ABSTRACT

EDUCATIONAL LEADERSHIP

FEARS, BRANDON B.S. CLARK ATLANTA UNIVERSITY, 1998

M.S. CLARK ATLANTA UNIVERSITY, 1998

M.S. GEORGIA STATE UNIVERSITY, 2002

ED.S. CENTRAL MICHIGAN UNIVERSITY, 2006

A COMPARISON OF THE IMPACT OF THE USE OF TECHNOLOGY VS.

TRADITIONAL TEACHING METHODOLOGY ON STUDENTS'

SCORES ON COORDINATE ALGEBRA MILESTONES

Committee Chair: Barbara Hill, Ed.D.

Dissertation dated May 2016

The purpose of this experimental research was to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment. Successful completion of Coordinate Algebra determines whether students receive a high school diploma and without a high school diploma students are ensuring themselves lives filled with low paying jobs, short-term employment, and a greater possibility of being incarcerated.

The participants for this research consisted of all regular education students who are classified as freshmen and divided into two groups for comparison purposes. The

dependent variables for this study included the following: (a) the posttest Coordinate Algebra scores for all students in the control group whose teacher used traditional methods of teaching Coordinate Algebra, (b) the posttest Coordinate Algebra scores for all students in the experimental group whose teacher used the TI-84 Graphing Calculator, (c) the students' perception on the impact of utilizing the TI-84 Plus Graphing Calculator, and (d) the teachers' perception on the impact of utilizing the TI-84 Plus Graphing Calculator.

The independent variables for this study were as follows: (a) the groups the students are in with 1 = control (traditional method) and 2 = experimental\treatment (TI-84 Plus Graphing Calculator), (b) the gender of the student, (c) the pretest score, (d) student attendance, (e) socioeconomic status, and (f) difference in Coordinate Algebra score gains.

The following question drove this research: What is the effect of the use of TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students as measured by their posttest scores? Furthermore, this experimental research examines the correlation between factors such as the non-use of the TI-84 Plus Graphing Calculator, gender and socioeconomic status (independent variables), and the academic success rate (dependent variable) of Coordinate Algebra students.

A COMPARISON OF THE IMPACT OF THE USE OF TECHNOLOGY VS. TRADITIONAL TEACHING METHODOLOGY ON STUDENTS' SCORES ON COORDINATE ALGEBRA MILESTONES

A DISSERTATION

SUBMITTED TO THE FACULTY OF CLARK ATLANTA UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE DEGREE OF DOCTOR OF EDUCATION

BY

BRANDON FEARS

DEPARTMENT OF EDUCATIONAL LEADERSHIP

ATLANTA, GEORGIA

MAY 2016

ACKNOWLEDGEMENTS

First and foremost, I dedicate this dissertation to God. I thank God for all that He has given me, and I could not have done this on my own. I also dedicate this to my parents, Benjamin and Carolyn Fears, who emphasized the importance of education. Thank you for the sacrifices you made over the years and the dreams you had to let go, just to give me a shot at achieving mine. To my big brother Simca, thank you for your unconditional love and support throughout my life. This dissertation is also dedicated to my loving and supportive family. To my wife, Shaundra, thank you for always being there in my times of need; your undying support has made this feat attainable. To my in-laws, Mac and Carol Mattox, thank you for your incredible support. To my children, Paige and Brandon, everything I do, I do for you. It is my ultimate dream that you aspire to be great and use education as a means to achieve your ambitions.

I would like to thank my incredible committee chair, Dr. Barbara Hill, for her patience, her willingness to answer my questions, and her incessant and relentless pursuit of my completion of this dissertation. I would like to thank my outstanding committee members, Dr. Trevor Tuner, Dr. Darrell Groves, and Dr. Theo Smith for pushing me toward excellence. I would like to thank Mrs. Cooke for all of the amazing support and guidance over the years. Lastly, I would like to acknowledge all of my friends, family, and coworkers for their outstanding support.

TABLE OF CONTENTS

CHAPTER

CHAPTER

APPENDIX

LIST OF FIGURES

Figure

LIST OF TABLES

Table

CHAPTER I

INTRODUCTION

Achievement in mathematics is vital to the education of all students. Present-day students will work and live in an age dominated by technology that significantly impacts the global economy. To provide 21st century students with the skills necessary for gratifying and productive lives in this modern era, the emphasis of mathematics education must change from the existing traditional practices, to the emphasis of a meaningful set of mathematics performance standards for all students. Today's mathematical courses include traditional classes such as geometry and algebra, as well as newer courses like discrete mathematics, statistics, and probability, which are intended to increase student mathematics success. Additionally, increasing mathematical knowledge must be a priority to all students to ensure success in this new global era. Knowing and understanding mathematics requires being able to employ mathematical concepts in many purposeful ways. To learn mathematics, students must be involved in communicating, conjecturing, exploring, and thinking, rather than only memorizing procedures and rules. Also, to ensure mathematical understanding, teachers must offer experiences that support students in recognizing the multifacetedness of mathematics and the relevance in daily life.

The relevance of technology is spreading to almost every field and has become a significant force in this modern era. Many view the current technology being used daily as tools to perform simple assignments. However, the utilization of technology for challenging and thought-provoking assignments transpires as well. While technology evolves to complete more thought-provoking tasks, the use of technology is becoming more apparent in education. Over 70% of the teachers in the United States noted that technology enabled them to reinforce and expand on content (Public Broadcasting Service [PBS], 2012).

In today's classrooms, technology is an essential component in the improvement of mathematics education and for that reason, school systems are providing more access to technology. In 2000, the National Council of Teachers of Mathematics (NCTM) challenged mathematics educators with the following proclamations:

> Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning. Technology should not be used as a replacement for basic understandings and intuitions; rather, it can and should be used to foster those understandings and intuitions. In mathematics instruction programs, technology should be used widely and responsibly, with the goal of enriching students' learning of mathematics. Technology does not replace the mathematics teacher. The teacher plays several important roles in a technology-rich classroom, making decisions that affect students' learning in important way. (pp. 24 – 26)

This challenge suggested that the use of classroom technology, as an instructional strategy, may influence and prompt student learning in mathematics. Numerous mathematics educators reason that technology has the capacity to validate concepts and offer enrichment that exceeds what students could do by hand. Currently, one of the most widely used technical tools in mathematics is the graphing calculator. Graphing calculators have the capability to manipulate equations or expressions, calculate precise values for equations or functions, and plot relations and graph functions. What mathematicians and students once had to perform by hand calculation, mathematicians and students are now able to utilize graphing calculators so students are able spend more time comprehending mathematical theories and concepts. Graphing calculators allow students to view and analyze graphs of functions with more detail than by merely sketching them by hand. Research suggests that graphing calculators permit students to concentrate on asking thought provoking questions as well as allow students to construct substantiation to dismiss or support mathematical concepts.

Statement of the Problem

Myers (2009) stated that a problem is something that makes a person bewildered and challenges their mind. This experimental research examined an obstruction that is puzzling most mathematics teachers, by what instructional strategies to use in order to increase the success of Coordinate Algebra students. Recently, the Georgia Department of Education released statewide data on how high school students performed on the Georgia End of Course Tests (EOCT). The most troubling performance was in Coordinate Algebra where only 37% of students met or exceeded the standard, meaning that 63% of the population failed (Downey, 2013). Dr. John D. Barge, the former superintendent of schools for the state of Georgia, made the following statements:

> The scores are a premonition of the challenges Georgia students will face as they encounter higher standards in their classrooms. The Coordinate Algebra results

> provide a first look at the new level of rigor that is coming with new federal criteria for state tests, where the expectations to meet standards will increase significantly. Coordinate Algebra was developed directly from the Common Core Georgia Performance Standards and the Georgia Frameworks and Curriculum Map for Coordinate Algebra. The Standards are grade-specific, but do not define the intervention methods or resources necessary to support students who are well below or well above grade-level expectations. All students must have the opportunity to learn and meet the same high standards if they are to access the knowledge and skills necessary in their post-school lives. These standards provide clear indicators along the way to the goal of college and career readiness for all students. The new cut scores on the Coordinate Algebra test are more in line with the higher level of expectations required for students to get into postsecondary institutions and not need remediation, as well as the expectations many of today’s jobs require, which is why fewer students met or exceeded the standard. (Downey, 2013, pp. A1, A4)

A new test system now being formed called the “Georgia Milestones Assessment System,” more aligned with the Common Core Georgia Performance Standards that Georgia has implemented, will replace the EOCT by the end of the 2015 school year.

The Georgia Milestones Assessment system will be more consistent with national measurements of educational achievement. According to Barge (cited in Downey, 2013), the math data for school year 2014 provide a glance of increased goals and expectations that will reflect the new Georgia Milestones Assessments. The former superintendent thinks that the Coordinate Algebra scores will specifically provide a clear indication of the increased expectation for student achievement that is approaching with the shift from the Georgia EOCT to the Georgia Milestones and the expectations of students meeting and exceeding the standards are substantially improving to create a realistic criterion of student performance.

Table 1 provides the data for the Coordinate Algebra EOCT results of a metropolitan school district located in Georgia where the experimental research occurred. The table displays how each school in this district performed in comparison to the overall Coordinate Algebra EOCT results for the state of Georgia. Included in this table are the number of students tested, the mean scale score, the percentage of the students that did not meet the standard (PL1), the percentage of the students that met the standard (PL2), the percentage of the students that exceeded the standard (PL3), the rounded scale score, the mean grade conversion score, and the overall passing percentage. Although there may be several reasons for the low student performance, this experimental research investigated the outcomes of the utilization of technology (TI-84 Plus Graphing Calculator) on the success of Coordinate Algebra students to determine if the proper use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment.

Table 1

Coordinate Algebra EOCT Results for the State of Georgia, 2014

School Name	N Tested	Mean Scale Score	Percent in PL1	Percent in PL2	Percent in PL3	Rounded Scaled Score	Mean Grade Conversion Score	Pass %
School 1	78	399.49	44.9	53.8	1.3	399	69	55
School 2	49	391.18	61.2	36.7	2.0	391	67	39
Georgia	118,903	391.12	63.1	32.4	4.5	391	67	37
School 3	310	389.39	63.5	33.5	2.9	389	66	36
School 4	311	386.98	65.9	33.1	1.0	387	65	34
Metropolitan School District	3,016	380.03	77.1	20.5	2.4	380	63	23
School 5	72	382.96	79.2	19.4	1.4	383	64	21
School 6	103	381.52	79.6	18.4	1.9	382	64	20
School 7	266	375.08	82.7	16.5	0.8	375	61	17
School 8	381	374.46	85.0	14.7	0.3	374	61	15
School 9	85	374.66	85.9	12.9	1.2	375	61	14
School 10	48	374.13	89.6	10.4	0.0	374	61	10
School 11	76	372.80	90.8	7.9	1.3	373	61	9
School 12	87	373.49	90.8	8.0	1.1	373	61	9
School 13	97	365.92	91.8	8.2	0.0	366	58	8
School 14	89	368.25	92.1	7.9	0.0	368	59	8
School 15	79	368.82	92.4	7.6	0.0	369	59	8
School 16	52	367.29	94.2	5.8	0.0	367	58	6
School 17	213	367.46	95.8	4.2	0.0	367	58	4
School 18	73	366.34	97.3	2.7	0.0	366	58	3
School 19	78	361.41	97.4	2.6	0.0	361	56	3
School 20	96	359.14	97.9	2.1	0.0	359	56	2
School 21	52	369.50	98.1	1.9	0.0	370	60	2

This research is an experimental study that compares two predominantly African-American lower socioeconomic Coordinate Algebra classes in a large school district located in one metropolitan school district located in Georgia. Students in the ninth grade are required take Coordinate Algebra (Algebra I GSE). According to the Georgia Department of Education (2014), the fundamental purpose of Coordinate Algebra is to formalize and extend the mathematics that students learned in the middle grades. The critical areas, organized into units, deepen and extend understanding of linear relationships, in part by contrasting them with exponential phenomena, and in part by applying linear models to data that exhibit a linear trend. Coordinate Algebra uses algebra to deepen and extend understanding of geometric knowledge from prior grades. Successful completion of Coordinate Algebra with a final grade of at least a 70% is a graduation requirement and 20% of the students' final grade is composed of the Coordinate Algebra Milestones Assessment.

Purpose of the Study

The purpose of this experimental research was to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment. Successful completion of Coordinate Algebra determines whether students receive a high school diploma and without a high school diploma students are ensuring themselves lives filled with low paying jobs, short-term employment, and a greater possibility of being incarcerated.

The participants for this research consisted of all regular education students who are classified as freshmen and divided into two groups for comparison purposes. The dependent variables for this study included the following: (a) the posttest Coordinate Algebra scores for all students in the control group whose teacher used traditional methods of teaching Coordinate Algebra, (b) the posttest Coordinate Algebra scores for all students in the experimental group whose teacher used the TI-84 Graphing Calculator, and (c) the students' perception on the impact of utilizing the TI-84 Plus Graphing Calculator.

The independent variables for this study were as follows: (a) the groups the students are in with 1 = control (traditional method) and 2 = experimental\treatment (TI-84 Plus Graphing Calculator), (b) the gender of the student, (c) the pretest score, (d) student attendance, (e) socioeconomic status, and (f) difference in Coordinate Algebra score gains (postscore/prescore).

The following question guided this research: What is the effect of the use of TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students as measured by their posttest scores? Furthermore, this experimental research examined the correlation between factors such as the non-use of the TI-84 Plus Graphing Calculator, gender and socioeconomic status (independent variables) and the academic success rate (dependent variable) of Coordinate Algebra Students.

Research Questions

The researcher used the following overarching research questions for empirical measurement:

RQ1: Is there a statistically significant difference between the posttest scores of the control group and the posttest scores of the experimental group?

RQ2: Is there a statistically significant difference between the pretest scores and posttest scores of the experimental group?

RQ3: Is there a statistically significant difference between the pretest scores and posttest scores of the control group?

RQ4: Is there a statistically significant difference between the gain scores of the control group and the gain scores of the experimental group?

RQ5: Is there a statistically significant difference between the pretest scores and posttest scores of the males in the experimental group?

RQ6: Is there a statistically significant difference between the pretest scores and posttest scores of the females in the experimental group?

RQ7: Is there a statistically significant difference between the pretest scores and posttest scores of the males in the control group?

RQ8: Is there a statistically significant difference between the pretest scores and posttest scores of the females in the control group?

RQ9: Is there a statistically significant difference between the pretest scores and posttest scores of the students who receive free/reduced lunch in the experimental group?

RQ10: Is there a statistically significant difference between the pretest scores and posttest scores of the students who receive free/reduced lunch in the control group?

RQ11: Is there a statistically significant relationship between attendance and the posttest scores of the students in the experimental group?

RQ12: Is there a statistically significant relationship between attendance and the posttest scores of the students in the control group?

RQ13: Is there a statistically significant relationship between the perception of the impact of utilizing the TI-84 Plus Graphing Calculator and the gain scores of the students in the experimental group?

Significance of the Study

Technology is the purposeful application of information in the production of services and is a wide-ranging instrument that can be utilized to launch students into a higher level of conceptual understanding. Students are more likely to improve decision-making, communication, and analytical skills and more likely to go to college when they learn high level mathematics. Moses and Cobb (cited in Myers, 2009) argued that students who learn higher level mathematics are superior problem solvers in high school and can evaluate an abstract situation more concisely than students who do not acquire the same mathematical knowledge. Moses and Cobb also stated that students can improve their livelihood and become successful and productive citizens if they improve their capacity to solve challenging and complex mathematical tasks.

Anick, Carpenter, and Smith (cited in Myers, 2009) stated that white students complete approximately a year more of high school mathematics than black students and compared to white students, black students do not understand mathematics on an abstract, deeper level. The 2005 National Assessment of Educational Progress study showed that minority students are lagging behind their non-minority counterparts. Moses and Cobb (cited in Myers, 2009) stated that minority students prepare themselves for a life fixed in a permanent underclass by not learning abstract or higher level mathematics at the same rate as their white counterparts and are increasingly drifting away from complex mathematics. Moses and Cobb argued that learning higher level mathematics is essential to upward mobility and being successful in life.

Lower socioeconomic students usually score significantly lower on standardized tests than affluent nonminorities and many educators believe that technology has the capacity to narrow the gap. Lubienski (2007) stated that even though lower socioeconomic status students are less motivated to learn than students with a higher socioeconomic status, these students can learn if they are taught with a more hands-on style and are more involved in the learning process.

Hyde and Lamon (cited in Myers, 2009) discovered that boys have more success in higher level mathematics than girls in high school and girls routinely score lower than boys on mathematics achievement tests. Hyde (cited in Myers, 2009) suggested that girls do not view mathematics as being important and are more interested in other subjects. Myers (2009) asserted that boys think more strategically than girls at the high school level and therefore boys are more interested in higher level mathematics. This experimental research was conducted to determine if the utilization of the TI-84 graphing calculator would influence or change the mathematics achievement difference between the two genders.

In utilizing technology in the mathematics classroom, the role of the school administration is critical for implementation. The actions and attitudes of school leaders embracing the utilization of technology will encourage and support teachers as they engage in learning opportunities and explore new tools to enhance instruction. Through their role as instructional leaders, school administration can ensure that the utilization of technology is prioritized and that the teachers feel comfortable using it.

Summary

At a stage in time when high school freshmen should be planning for a productive life filled with optimism and hopefulness, these students are formulating themselves for a lifetime of bleakness and desolation by failing Coordinate Algebra at an alarming rate. This experimental research study aimed to discover if learning mathematics via the utilization of the TI-84 Plus Graphing Calculator may be an option to switch the trend of declining scores in the area of mathematics.

CHAPTER II

REVIEW OF THE LITERATURE

The NCTM Principles and Standards for School Mathematics (2000) defined several principles for school mathematics, one of which was the Technology Principle. The Technology Principle acknowledges that technology influences the mathematics that is taught and improves students' mathematical knowledge and is essential in teaching and learning mathematics. The Technology Principle also acknowledges technology, such as graphing calculators, are effective in enhancing instruction by allowing students to perform tedious calculations faster, presenting processes and findings more clearly, and organizing data for graphs and tables efficiently.

This chapter presents an overview of the research and literature relating to this experimental research and an outline of the research questions. The literature in this experimental research includes the effectiveness of technology, the role of leadership in utilizing technology, the impact of technology on today's instructional program as it relates to Science, Technology, Engineering, and Math (STEM), the effectiveness of the graphing calculator, the mathematics success of students from low socioeconomic circumstances, and the mathematical success of the two genders.

Utilizing Technology

Moses and Cobb (cited in Powell, 2009) stated that minorities can learn advanced mathematics via the utilization of technology. The researchers originated the "Algebra

Project," a mission founded on the principle that mathematics literacy is a precondition for full citizenship in society. Moses and Cobb viewed technology as an equalizer that assists in the organization of thoughts and viewed algebra as the language of computers. According to Moses and Cobb, algebra is the entryway to advanced mathematics and students must have an understanding of algebra as a prerequisite to being computer literate. Even though algebra is traditionally a secondary course, Moses and Cobb thought algebra should be offered in the middle grades, and argued that students are on a pipeline to advanced placement calculus by taking algebra in the middle grades. Moses and Cobb suggested via the utilization of technology, students can gain a deeper and more abstract understanding of mathematics and ultimately become productive citizens. Moses and Cobb argued that students are guaranteeing themselves a "sharecropper's education," (a culture of lowest possible opportunities), grooming themselves for a life of poverty, if they fail to learn mathematics. According to Moses and Cobb, utilizing technology in the classroom is one of the most effective ways to promote student achievement in mathematics and prevent future life hardships.

In the 21st century classroom, technology appears in countless forms. Technology may be as minimal as use of a promethean board, the use of calculators in the mathematics classroom, a desktop or laptop computer in the classroom for student use, or the modern computer software. According to Alagic (cited in Cennamo, Ross, & Ertmer, 2009), instructors of higher level mathematics must be able to also use and teach the technology. Alagic also noted that teachers often teach mathematics using the same methods and strategies used when the teachers were receiving instruction while enrolled in school. Alagic believed teaching using antiquated methods is the reason veteran teachers teach utilizing the lecture method or traditional methods because the teachers were educated this way, and educators are content in providing instruction using the same traditional method. Students of the 21st century are very computer literate and are very savvy using technology, whereas experienced teachers are learning how to use technology from students. The NCTM key standard suggested technology is vital in supporting students gain a deeper understanding of higher level mathematics and is regarded as the means to help students obtain a conceptual understanding of the complexities of higher level mathematics (NCTM, 2011). Alagic (cited in Cennamo, Ross, & Ertmer, 2009) argued that technology such as the graphing calculator enables students to learn because it is interactive and affords students the opportunity to observe changes instantaneously, thus gaining a deeper understanding of what happens when a component of a function is altered. Technology reduces the computational restrictions and consequently expands learning.

The NCTM standards suggest that technology should be used to solve problems in an effort to obtain a deeper understanding of mathematical properties. This is comparable to using a scientific calculator to calculate the cubed root of an integer, but not fully comprehending what the answer signifies (NCTM, 2011). The NCTM Principles and Standards of 2000 suggest that technology enables students to investigate the effects of changes in the constraints of functions and gain a deeper comprehension of relations and functions. The underlying purpose of utilizing technology in the mathematics classroom for understanding forces students to think about what is transpiring in the concrete mathematics operations; preceding to additional means of answering and solving problems (NCTM, 2000).

The Role of Leadership in Utilizing Technology

In utilizing technology, the role of the school administration is critical throughout every stage of implementation. The actions and attitudes of school leaders embracing the utilization of technology will encourage and support teachers as they engage in learning opportunities and explore new tools to enhance instruction. Through their role as instructional leaders, school administration can ensure that the utilization of technology is prioritized and that the teachers feel comfortable using it. Effective leadership in promoting the use of technology means that the school administration must play multiple roles in the change process, including motivator, facilitator, leader, role model, and resource provider (Center for Implementing Technology in Education, 2015).

Table 2 illustrates the roles and responsibilities of the school administration promoting technology. It is also important that school administration have close working relationships with district-level leaders and technology coordinators. By working together as a team of change leaders, these individuals are able to ensure that technology implementation is carried out in an effective manner that aligns with the district’s vision for technology. This team-based approach can also ensure fidelity and consistency to reforms in cases of turnover (Center for Implementing Technology in Education, 2015).

Table 2

Roles and Responsibilities of the School Administration Promoting Technology

Administrator Role	**Responsibility**
Motivator	• Encourages and supports teacher efforts • Makes using technology a priority
Facilitator	• Identifies barriers and facilitators to technology integration • Provides teachers with learning opportunities
Leader	• Sets the tone by setting high standards for learning, cooperation, and collaboration
Role Model	• Leads by example • Encourages teachers to learn new things • Engages in learning alongside teachers
Resource Provider	• Ensures that teachers have the resources they need

Again, the school administrator plays an important role in incorporating technology. As role model and motivator, the school administrator must assist in building a school culture where teachers work collectively towards a shared vision. The school administrator must also ensure that teachers have the support and resources needed for utilizing technology, and that selected technology tools are connected to teaching curriculum and practice and curriculum (Center for Implementing Technology in Education, 2015). Additionally, school administration must influence school culture to encourage the scaling up of technology to attract attention to teacher successes through the use of newsletters and bulletin boards.

The Impact of Technology on Today's Instructional Program as it Relates to STEM

According to DeAngelis (2014), "Ninety-five percent of teachers agree that technology use in the classroom can enhance student learning" and that "eighty percent agree that their students' learning is more engaging when using technology" (p. 3). DeAngelis argued that student engagement can be accomplished via project-based programs such as The Project for STEM Competitiveness, which enhances problem-solving and allows students to utilize their prior knowledge to gain understanding of new concepts. DeAngelis also argued that whenever students are exposed to technology they are also being exposed the benefits of Science, Technology, Engineering, and Mathematics (STEM). DeAngelis stated that education needs to change to meet today's educational challenges. He noted that the percentage of lower socioeconomic status students is growing, which indicates that their exposure to sophisticated technologies could be constrained because of financial hardships. While the percentage of lower socioeconomic status students increases, higher socioeconomic status students are improving faster than lower socioeconomic status students. This trend is damaging both for the students being left behind and for America. History has shown that the best way for students to escape poverty is via education and educated students are better prepared to face life's obstacles and to take advantage of opportunities. Even though there are many components to an effective classroom, DeAngelis (2014) strongly believed that technology has an important role in today's classroom. "It's not about the technology; it's about sharing knowledge and information, communicating efficiently, building learning communities and creating a culture of professionalism in schools. These are the key responsibilities of all educational leaders" (DeAngelis, 2014, p. 5).

Using the Graphing Calculator

Graphing calculators are calculators with a large display screen that are programmed and used for graphing, solving equations, and various other tasks. Teachers enhance the opportunities for students to learn advanced mathematics topics that involve graphing and computing by incorporating the use of graphing calculators into their mathematics classrooms. By affording students the opportunity to learn advanced mathematical concepts through experience using a graphing calculator, students enhance mathematical knowledge by allowing them to see a visual of the results displayed on the screen. The graphing calculator also affords students the opportunity to explore advanced mathematical concepts through personal experience. Ford (2008) suggested that graphing calculators have several ways to present information and can perform routine operations faster than what pencil and paper manipulations.

Utilizing a two-way system of electronic communications, such as the graphing calculator in the mathematics classroom, affords students the opportunity to get an instantaneous response to a problem. Instant feedback creates excitement and increases students' interest in the mathematical concept being taught. Students are able make discoveries and explore ideas through experience when allowed to use interactive technology. As a result, students' discoveries are more real, and students gain a more abstract and deeper understanding of the mathematical concept being taught (Sabry & Barker, 2009).

Many mathematics educators and constructivists view graphing calculators as being beneficial in the mathematics classroom because the graphing calculator allows students to discover relationships between advanced mathematical concepts by giving different representations (Ford, 2008). Affording students the opportunity to experience concepts utilizing the graphing calculator has many benefits. Using the graphing calculator does not negatively affect the learning of traditional mathematics, the graphing calculator in fact allows students to become superior problem solvers. Hollar and Norwood (cited in Bismarck, 2009) discovered that mathematics students who were given the opportunity to have a firsthand learning experience of using the graphing calculator, felt more comfortable with data in real-world situations than the conventional students who did not use graphing calculators. The use of graphing calculators in the mathematics classroom gives students an opportunity to explore the effects of different values on functions and graphs and gives a personal experience with analyzing data (Ford, 2008).

Graphing calculators also aid struggling students in developing mathematics abilities by learning through personal experience. Students are able to use graphing calculators to graph functions of a higher degree and as a support for answering and explaining problems. Using graphing calculators encourage students to discover mathematical concepts and the experience acquired from its usage give students a deeper understanding of the correlation between complex graphs and equations.

Students are able to view findings as a graphical representation on the display screen of a graphing calculator and discover that it is less complicated to learn mathematical concepts. Using the graphing calculator is also faster than calculating and graphing by hand. Students experience mathematical representations through the graphing calculator which helps the students gain a deeper understanding of the mathematical concept, and make connections that help improve their overall comprehension. Graphing calculators increase computational skills and meaningful understanding of key mathematical concepts. Graphing calculators also make it less complicated for students to access both graphical and computational results, and ultimately improve scores on noncalculator assessments. As a result of the many benefits of utilizing the graphing calculator, today's mathematics classrooms have experienced an increased use of technology and graphing calculators (Ford, 2008).

The graphing calculator "has a positive effect on students' understanding of graphs and their connection to algebraic representation" (Ford, 2008, p. 8). Graphing calculators can facilitate the mathematics learning process by eliminating some of the mundane or tedious calculations. Graphing calculators expand the space that is integral to mathematical thinking and problem-solving. Graphing calculators also expand the capacity to raise mental processes that may otherwise not be as easy or even impossible to engage in. In doing so, graphing calculators help develop mathematical thinking and problem-solving.

According to NCTM (1989), all students in grades 9-12 should have access to graphing calculators. Idris (2006) stated that some teachers view the use of calculators as a crutch and think calculators will replace some basic math skills. Teachers against the use of technology in the mathematics classroom have a couple of arguments. The first argument for teachers not wanting to incorporate technology into the mathematics classroom is the teachers own lack of technology knowledge (Wenglinsky, 2005). Wenglinsky stated that not only are some teachers "intimidated by technology" and do not use technology in their classrooms, these teachers dislike teachers that are not intimidated by technology and who integrate technology into their classrooms.

"A positive classroom environment creates a positive foundation for direct instruction to occur" (Idirs, 2006, p. 2), and students need to feel wanted and valued in the mathematics classroom. According to Ford (2008), "Learning with a calculator contributes broadly to student achievement as measured on tests that allow calculator use" (p. 4). According to the Center for Implementing Technology in Education (2015a), proper use of graphing calculators in the mathematics classroom improves students' ability to comprehend advanced mathematical concepts and answer challenging problems. The graphing calculator has the capabilities to display data using multiple representations similar to the way manipulatives such as Geoboards and Unifix Cubes are used in elementary schools. In both the middle and high school setting, students need more advanced tools that enable them to establish a connection between abstract ideas and prior knowledge (Center for Implementing Technology in Education, 2015).

A study conducted by the Office of Program Evaluation (OPE) (2009) indicated that students in the 12th grade who used graphing calculators daily scored on average 9% higher on mathematics assessments than students who did not use graphing calculators daily. Research suggests that the incorporation of graphing calculators in the mathematics curriculum may positively affect students' problem solving skills and ultimately raise student achievement in mathematics. Meyers (2009) conducted an analysis that confirmed student enjoyment in mathematics increases with the inclusion of graphing calculators. As with other studies, the contribution of these calculators not only allows these students to enjoy mathematics, but also achieve at levels much higher than normally associated with their socioeconomic status (SES). Meyers stated that graphing calculators are used as a strategy to improve mathematics scores with students in Texas who are failing state assessments. Meyers (2009) observed that calculators are introduced as a strategy to raise test scores and close achievement gaps in high poverty schools. Researchers have established that the addition of graphing calculators is a possible tactic to increase student achievement and close achievement gaps. However, to be effective, the calculators must be used consistently. According to Myers (2009), students must consistently use graphing calculators for all assignments in order to measure the effectiveness of the graphing calculator and student learning. The purpose of this experimental research is to determine if the use of the TI- 84 graphing calculator can improve student achievement. This awareness may be used to create significant variations in the way educators strive to lessen achievement gaps in mathematics. As the utilization of graphing calculators in preparation for standardized assessments intensifies, the availability of graphing calculators has become a concern of equity in schools. Dunham (cited in Ford, 2008) acknowledged that extensive accessibility of graphing calculators can offer equity between low and high performing students. Alternatively, Jones (2006) specified that inequity may result when some students can afford graphing calculators and others cannot. The U.S. government has been struggling to increase the achievement of economically disadvantaged students since 1965, when President Lyndon B. Johnson declared a “War on Poverty.” Therefore, inequity in education is not a new issue. As part of this struggle, Title 1 funding is afforded to schools in order to meet the needs of students from low SES backgrounds. The Head Start Program was employed in 1965 to offer low-income students the chance to be ready for school and have equal readiness. In 2001, NCLB was employed to assure that all students were assessed equally and that all students were provided access to a suitable education. By affording students access to graphing calculators may close the achievement gap in mathematics by assuring students are equipped with the skills necessary to thrive on mathematics’ standardized assessments. The existing research supports the idea that graphing calculators can improve student achievement and proposes that the employment of graphing calculators can close achievement gaps.

Mathematics and Gender

Tiedemann (cited in Eccles, 2014) observed that girls outperform boys in mathematics during the first three grades. Eccles (2014) argued that boys outperform girls in high school. Eccles states that boys outperforming girls in high school occurs because less computation is required in the high school classroom, and girls are superior at computation. However, Tiedemann (cited in Eccles, 2014) stated that teachers often believe the difference in mathematics achievement between boys and girls is major because boys are more logical and, therefore, have an advantage over the girls. Tiedemann stated that teachers believe that some girls can contend with boys in high school mathematics, but this is only because girls know how to work hard when the necessity arises. Tiedemann conducted a study of both boys and girls in grades four through six to determine if boys were more mathematically advanced than girls. His longitudinal research consisted of 75 students and 3 teachers, and revealed that there are no substantial variances in mathematics success based on gender. Conversely, Tiedemann's participants were in grades 4 through 6 and the participants in this proposed experimental research study were classified as freshmen taking Coordinate Algebra. The goal of this experimental research study was to assess ninth grade Coordinate Algebra students to determine if there was a correlation between the use of the TI-84 Plus Graphing Calculator and the gender of the student. Eccles (2014) steered a study to examine teachers' perceptions regarding gender and the teachers' effect on sixth grade students' success in mathematics. Eccles determined that (a) the teachers as well as the students have different beliefs for the boys and girls in mathematics, (b) the teachers deem that the average achieving boys are more logical than the average achieving girls, and (c) teachers rate mathematics more difficult for the average achieving girls than for the boys on the same level.

Additionally concerning the girls, the teachers stated that their failures have less to do with a lack of effort and more to do with low ability. In Eccles' (2014) longitudinal study, the sixth grade boys outperformed the girls in mathematics. Eccles argued that girls that range from below average to average in mathematics achievement must try harder than the below average to average boys to achieve the same success in mathematics. The results supported that the boys were more logical and employ more determination towards acquiring mathematics knowledge than girls. Eccles perceived comparable findings in the way that parents viewed their sons and daughters differently.

Rebhorn and Miles (cited in Spikes, 2008) conducted a study to determine if standardized testing is an obstacle for gifted girls in the middle grades. Rebhorn and Miles theorized that if girls' scores were less than the boys on high-stakes mathematics tests, it would unfavorably affect girls' chances of being accepted into concentrated mathematics programs that could ultimately lead to networking opportunities, college admissions, and the capacity to learn how to interact in advanced academic settings. Rebhorn and Miles discovered that there was a 30 point difference, in favor of the males, in all of the mathematics scores of girls and boys on the Scholastic Achievement Test (SAT). According to Eccles (2014), boys are more likely to be admitted into advanced mathematics programs if the SAT math test is the sole factor. Benbow and Stanley (cited in Spelke, 2005) also piloted a similar study that revealed 67% of the students that took the mathematics part of the SAT and scored at least a 500, were boys. This experimental research sought to determine if TI-84 Plus Graphing Calculator could support girls in increasing their mathematics achievement. Lubienski (2007) claimed that gender bias was built into the SAT, and boys had a partial advantage over girls (Spikes, 2008). Lubienski's research acknowledged built-in gender biases in standardized tests and did not use students' socioeconomic status as a factor in his argument of results; the TI-84 Plus Graphing Calculator was not used in the researchers' study to prepare the students for the SAT. This experimental research is grounded on the use of TI-84 Plus Graphing Calculator to assess its effects on students' mathematics achievement as measured by their posttest results. Through the use of the TI-84 Plus Graphing Calculator, both the boys and the girls are afforded the same opportunities to excel and learn. The inquiries of variances in mathematics scores due to gender will be observed. Dix (2005) conducted a study on boys and girls in the eighth grade using technology via geometry's sketch pad as a treatment for the experimental group and paper and pencil for the control group and administered an attitudinal survey. The findings of Dix's survey showed a substantial difference in how boys and girls view technology and revealed that both boys and girls think positively of technology. Nevertheless, an examination of the survey findings disclosed that boys think more optimistically of technology than girls. Dix's findings also revealed that via technology, girls could perform advance reasoning on mathematical problems, thus giving girls additional motivation to achieve just as much or conceivably more than the boys.

According to Buddin (2014), female high school students earned higher grades than males. The gender gap was predominantly large in language arts, but female students also earned higher grades in social science courses. The differences between male and female students' scores on achievement tests, as measured by scores on the American College Testing (ACT) college readiness assessment, were less consistent than the differences seen in student course grades. Even though female students outperformed male students in language arts and social sciences and the overall ACT composite scores of males and females were similar, the male students had superior achievement levels on both the math and science portions of the ACT. While both ACT test scores and student course grades measure academic achievement, they may define dissimilar parts of it.

Student course grades reflect daily performance in an academic course, but students are often rewarded or penalized for noncognitive factors that are not direct measures of academic learning (Buddin, 2014). For example, teachers may lower grades for students with inattention, incomplete assignments, or disruptive behavior. Buddin argued that male students get lower grades because they have more behavioral issues and are less attentive in school. In contrast, ACT test scores are a point-in-time estimation of academic achievement. Because the ACT omits items that might produce a gender bias, it offers an objective, comprehensive measure of student learning.

Altermatt and Kim (2004) stated that boys surpass girls in mathematics because boys are exposed to hormones in the womb that steer more to logical reasoning in the brain. Altermatt and Kim also contended that girls sometimes have "low confidence and high uncertainty," and that these virtues are uncovered during mathematical reasoning. Altermatt and Kim expanded on an additional theory that states "girls are more likely than boys to want to please others, whereas boys are more competitive;" this may serve as an explanation for the difference between the mathematics achievement of boys and girls. The intent of this experimental research was to compare the posttest results of boys and girls taking Coordinate Algebra to determine if the use of the TI-84 graphing calculator affects the posttest results.

Parents play a large role in the perceptions of children's attitudes towards mathematics (Altermatt & Kim, 2004). Altermatt and Kim contended that boys exhibit superior confidence in mathematics abilities because boys view mathematics as a male-dominated arena. Altermatt and Kim also noted mothers often have low expectations of daughters' level of achievement in regards to mathematics, often motivating the daughters not to work hard to increase achievement levels. In addition, LaLonde, Leedy, and Runk (2003) claimed that "teachers have different perceptions of boys and girls mathematically" (p. 45) and the teachers in their study showed special treatment towards the boys and paid less attention to the girls' mathematical capabilities. The findings of Altermatt and Kim were based on a survey that was given to all of the participants, and its purpose was to assess both the parents' and students' perceptions of mathematics. The daughters and mothers believed that the survey was biased and insulting to women because the questions were geared to display male supremacy. Martinot and De'sert (2007) surveyed fourth and seventh graders to ascertain whether students were aware of gender stereotypes. According to their findings, seventh grade boys assumed that girls were academically superior in mathematics. However, the girls believed that their mathematical abilities were much lower than the boys. This research offers additional confirmation that boys reason or think differently than girls. Bracey (2006) argued that boys view mathematical problems differently than girls, and that

> [b]oys use a top-down approach in which they quickly identify what category a problem belongs to and make adjustments accordingly, whereas girls use a bottom-up method in which they look for patterns as they pull together information from the problem. (p. 23)

Bracey hypothesized that girls are more likely to spend time examining meaningless material as the girls try to answer a problem and states that boys disregard meaningless information and follow established procedures and calculations for problem solving. By using the TI-84 Plus Graphing Calculator, students will have the potential to rapidly examine, make assumptions, and decide if certain mathematical properties are applicable. In addition, the use of TI-84 Plus Graphing Calculator may have the capabilities to support girls in answering problems effectively.

According to Altermatt and Kim (2004), students in the primary grades did not have a gender gap in the area of mathematics. Altermatt and Kim stated that "gender differences in mathematics begin to occur in the middle grades, and that when time constraints are removed from tests, girls perform just as well or better than boys" (p. 55). Altermatt and Kim also maintained the following:

> In the lower grades, girls outperform boys in mathematics and as students move into the middle grades, boys are expected to take the lead in mathematical abilities over the girls. Beginning in middle school, the boys do take a lead in mathematics achievement. (p. 61)

This experimental research aimed to discover if the use of TI-84 Plus Graphing Calculator could support girls in narrowing the mathematics achievement gap that exists in the nonprimary grades.

Socioeconomic Status

The No Child Left behind (NCLB) Act of 2001 states that all students will work on grade level within a 10 year period (United States Department of Education [USDOE], 2009). NCLB was created to terminate the achievement gap between students of low and high socioeconomic status and between minority and nonminority students. The promises of the NCLB are idealistic but the realities are entirely dissimilar because countless students and school districts are continuously left behind. In 2004, a major school system implemented a "School Improvement Zone." The Zone is a group of schools and their feeder programs from habitually underprivileged districts that continuously trail in achievement. The Zone's mission is to help the underprivileged schools by supplying additional resources and creating an extended school day to help students to close the achievement gap between the schools with students in the more affluent districts. An evaluation of the program was conducted three years after its initiation and the findings reveal that the Zone is slightly operational in improving student mathematical achievement (Office of Program Evaluation [OPE], 2009). This experimental research sought to determine if students could increase their mathematics competence through the use of TI-84 Plus Graphing Calculator.

Lubienski (2007) stated that it is important to address socioeconomic factors which often affect the spread of the achievement gap of students and maintained the following:

> Despite the huge changes that have occurred in the way that economically disadvantaged students have been taught since 1989, students with higher socioeconomic status have continued to increase the achievement gap even to the point of the difference being more than several grade levels. (p. 43)

Lubienski gave numerous reasons why students of lower socioeconomic status were not on an equivalent academic level as students of higher socioeconomic status. One thought was that the students of a lower socioeconomic status were strongly against trying to discover mathematics through problem solving and discussion. Lubienski argued that students of a higher socioeconomic status discuss different ways of solving difficult problems and bounce ideas off of one another. According to Lubienski (2007), socioeconomically disadvantaged students struggled comprehending many mathematical theories that were discussed and students of a higher socioeconomic status were often intrinsically motivated to learn the mathematical concepts whether a teacher was present or not. Lubienski's research implied that the lower socioeconomic status students often said to the instructor "tell me the answer," and "how do you do it?" without making any attempts to discover the answers for themselves. Lubienski argued that students of a lower socioeconomic status were rapidly confused and were not certain if they were accurately answering questions, while students of a higher socioeconomic status habitually discerned that the same mathematical concepts were repeated in various ways. Lubienski also noted that students of a lower socioeconomic status exercised a common-sense approach to thinking through mathematics and were absorbed in the semantics of a problem, thus letting the essential mathematics concepts of a problem pass them by. This experimental research sought to discover if students of a lower socioeconomic status could close the achievement gap with their higher socioeconomic status peers and afford lower socioeconomic status students the opportunity to build on the mathematics they already know, learn new mathematical concepts, and develop new mathematical arguments by utilizing the TI-84 Plus Graphing Calculator.

According to Lubienski (2007), "Sustained mathematical achievement is the way to higher paying occupations, and students of lower socioeconomic status should be aware that the more they learn, the better their chances are of getting higher paying jobs"

(p. 69). Lubienski asserted that lower socioeconomic status students were more likely to memorize mathematical facts, unlike their counterparts, and this manner was vastly linked with undesirable mathematical achievement. This experimental research attempted to discover if the use of the TI-84 Plus Graphing Calculator could motivate students to do mathematics, and discover and learn mathematical concepts that may ultimately help the students in passing the Coordinate Algebra Milestones Assessment.

Parents of students with a lower socioeconomic status are apprehensive and intimidated by their child's school and frequently feel attacked or perplexed by teachers at parent conferences and are less likely to attend meetings to seek additional assistance for their children. In contrast, parents of students with a higher socioeconomic status habitually attend teacher conferences, demand that their child obtain additional help and are inclined to request higher authority to ensure that their child's needs are met (Lubienski, 2007). According to Lubienski, students with a lower socioeconomic should have more resources and the best teachers to ensure these students have an opportunity to become just as successful as students of a higher socioeconomic status. Through the use of the TI-84 Plus Graphing Calculator, this experimental research strives to help lower socioeconomic status parents by reducing the necessity for the parents to pursue mathematical assistance for children by increasing the probability of the children passing the Coordinate Algebra Milestones Assessment and becoming a huge step closer to the goal of graduation. Ogwu (2004) stated the following:

> Parents that have high socioeconomic status have greater access to outside resources for their children's educational attainment and have the ability to send

> their children to schools of high standards and are able to purchase computers, learning toys, and other amenities that parents of children of low socioeconomic status cannot afford. (p. 45)

According to Ogwu (2004), the parents of students of higher socioeconomic status have the means that children need to ensure success, while the parents of students with lower socioeconomic status do not possess the means to ensure success. Benefits such as tutors, computers, and innovative mathematics programs are amenities that parents of students with lower socioeconomic status cannot afford.

Summary

This chapter began with an investigation of the research questions and a discussion of the literature on the use of technology. This experimental research intends to complement the existing literature in exploring how the use of the TI-84 Plus Graphing Calculator affects students' achievement in mathematics. This chapter highlights the validity of the gender gap on students and suggestions on how to deal with this issue and implications on how to increase the mathematical success of students of a lower socioeconomic status.

It is the duty of educational leaders to discover effective methods of teaching and motivating all students to achieve a high level of success in the area of mathematics. This experimental research study investigates whether the use of the TI-84 Plus Graphing Calculator will allow low socioeconomic status students to achieve mathematics success and learn complicated mathematical concepts that could ultimately help them pass the Coordinate Algebra Milestones Assessment. The literature suggests that students are motivated to exceed in learning new mathematics concepts through the use of technology.

CHAPTER III

THEORETICAL FRAMEWORK

This chapter provides the theoretical framework, definition of variables and other terms, research questions and the limitations of the study.

Theoretical Perspective

The constructivist theory of learning is the theoretical perspective of this experimental research. This theory implies that students build knowledge by using prior knowledge to make connections to new concepts. Countless educators consider the constructivist theory of learning as a recent concept in modern education although its principles were a practice of Socrates. Socrates is well recognized for asking questions that would broaden his students' intelligences and influence his students to think on an advanced level. John Dewey (cited in Clark, 2006) is the architect of a technique called "the project method" which inspires students to work together in groups in effort to find answers to diverse problems that might occur as they complete a challenging task. Dewey (1916) indicated the following:

> The project method is a means of discovery and proof in so much as all thinking results in knowledge, ultimately the value of knowledge is subordinate to its use in thinking. The way that we interpret things is the eye that we see them through. (p. 16)

Dewey believed that the learner is the active participant in the learning process, and the instructor should only act as a facilitator. Jean Piaget (cited in Clark, 2006), one of the most significant researchers in the area of developmental psychology during the 20th century, stated that "the mind's primary function is to create and to see things in a way that can be organized into a schema that helps the mind to see them as being real" (p. 22). Piaget, a supporter of cognitive development, stated "as children grow older, they look at the world through different experiences, and that children have completely different perspectives than adults" (p. 23). Piaget also stated, "When knowledge is constructed within oneself, it is examined against what is happening in the real world in much the same way that a scientific idea is tested" (p. 24). Bruner, Glasersfeld, and Vygotsky are also modern-day constructivist theorists. Glasersfeld's (cited in Kenny, 2007) constructivist view involves two principles:

1. Knowledge is always being created, built up by learner. It is not inertly established;
2. Coming to know is a course of action based on the learner's constant adaptations to the experiences of the world.

Glasersfeld (cited in Kenny, 2007) is a key supporter of abstract philosophies that suggest learner's experiences construct conceptual structures via self-regulation and indicates that true knowledge occurs when a learner takes ownership of a challenging problem. Vygotsky (cited in McLeod, 2010) developed a "zone of proximal development" (p. 74) which is essentially the contrast between what the learner already knows and what that learner has been taught by others. Vygotsky stated that students acquire knowledge via social collaboration and by discovering concepts by solving problems with their peers.

He calls this practice "scaffolding" (p. 78). Bruner (cited in McLeod, 2008) stated that learning is a procedure that happens via social collaborations, and students gain new knowledge by attaching onto prior knowledge: The learner chooses information, creates a hypothesis, and formulates a conclusion, with the intention of incorporating new knowledge into existing rational ideas. He believed that cognitive constructions provide sense and structure to previous experiences and permit students to surpass the limitations of the knowledge previously known. According to Bruner (cited in Thanasoulas, 2008),

> Student independence, fostered through encouraging students to discover new principles of their own accord lies at the heart of effective education. Moreover, curriculum should be developed in a spiral manner so that students can build upon what they have already learned. (p. 43)

The students in this experiment research will add to their prior knowledge in effort to gain a deeper comprehension of Coordinate Algebra via the use of the TI-84 Plus Graphing Calculator.

Student Outlook

Groman (cited in Myers, 2009) argued that technology educates students through the medium of the constructivist theory of learning. Groman (cited in Myers) stated that students do not just memorize facts but are in control of learning through the constructivist theory of learning. Groman (cited in Myers) contended that students discover knowledge through personal experience and keenly involved in the discovering activity. From a constructivist viewpoint, the responsibilities and responsibilities are regularly exchanged as the students and teachers learn from each other. While acquiring knowledge via the constructivist theory of learning, students acquire knowledge from whole to segments. The interests and beliefs of students must propel the learning process. According to Piaget (cited in McLeod, 2009), the student activities are not curriculum-centered but student-centered. Piaget reasoned that the needs of the learner are the leading point when choosing tasks and not what the instructor wants to teach. Piaget also reasoned that students need to obtain "schemas" in order to discover understanding and defines schemas as a collection of actions, perceptions, and ideas. Schemas allow the learners to develop relationships that are discrete or concrete. For instance, a child identifies a vehicle, and once the child perceives dissimilar styles of vehicles, the child is able to discern that the vehicles are not the same. Since the child knows the vehicles are not the same, the child is able to infer that one vehicle is a Hummer and the other vehicle is a Toyota. When the learner progresses, new schemas are created. In this experimental research, students will form new schemas via the TI-84 Plus Graphing Calculator.

Teacher Outlook

According to Gray (cited in Kenny, 2009), the following characteristics must exist in constructivist classrooms:

1. Power and control must be shared between the teacher and student.
2. Classrooms must be student-centered;
3. Teachers must employ negotiation by disseminating knowledge and facilitating learning;
4. Teachers must be researchers.

Gray asserted that emphasis on the learners is paramount because the learners are the interpreters of the disseminated information and maintains that negotiation is significant because it partners the teacher and the students into a shared goal and is essential to personalize each class explicitly for the students. Constructivist teachers encourage learners to provide involvement as to where to go in the learning progression. Gray suggested that teachers should encourage students to provide involvement as to where to go in the learning progression and study students on a daily basis by gaging student needs, observing their progress, and plowing in deeper to support the way the students learn. Gray alleged that empowering the students is paramount in creating a constructivist classroom; students must know that students are in command of what is being thought. Caine (2004) listed 12 principles of constructivist teaching.

1. **The brain is a parallel processor**. The brain rapidly processes many different types of knowledge and successful teaching employs a variety of learning approaches.
2. **Learning engages the entire physiology**. Teachers must address more than just the intellect.
3. **The search for meaning is innate**. Successful and efficient teaching recognizes that meaning is unique and personal, and that students' intelligences are based on their own experiences.
4. **The search for meaning occurs through "patterning."** Successful teaching connects isolated information and ideas with global themes and concepts.
5. **Emotions are critical to patterning**. Obtaining new knowledge is influenced by attitudes, feelings, and emotions.

6. **The brain processes parts and wholes simultaneously**. Students struggle to learn when either parts or wholes are disregarded.
7. **Learning involves both focused attention and peripheral perception**. The student’s culture, climate, and environment influence student learning.
8. **Learning always involves conscious and unconscious processes**. Time is needed for students to process “what” as well as 'how' they've acquired new knowledge.
9. **We have at least two different types of memory: a spatial memory system and a set of systems for rote learning**. Teaching that stresses routine learning does not promote learning through experience and can obstruct understanding.
10. **We understand and remember best when facts and skills are embedded in natural, spatial memory**. Learning from previous experiences is effective.
11. **Learning is enhanced by challenge and inhibited by threat**. The classroom culture and climate should not be threatening but challenging to students.
12. **Each brain is unique**. Teaching must be multifaceted to allow students to express preferences. (pp. 1-2)

Definition of Variables and Other Terms

Dependent Variables

The dependent variables for this study included the following: (a) the posttest Coordinate Algebra Milestones scores for all students in the control group whose teacher used traditional methods of teaching Coordinate Algebra, (b) the posttest Coordinate

Algebra Milestones scores for all students in the experimental group whose teacher used the TI-84 Graphing Calculator, and (c) the students' perception on the impact of utilizing the TI-84 Plus Graphing Calculator on their Coordinate Algebra Milestones score gains (postscore/prescore).

Independent Variables

The independent variables for this study were as follows: (a) the groups the students are in with 1 = control (traditional method) and 2 = experimental\treatment (TI-84 Plus Graphing Calculator), (b) the gender of the student, (c) the Coordinate Algebra Milestones pretest score, (d) student attendance, (e) socioeconomic status, and (f) difference in Coordinate Algebra Milestones score gains (postscore/prescore). Figure 1 depicts the relationship among the variables.

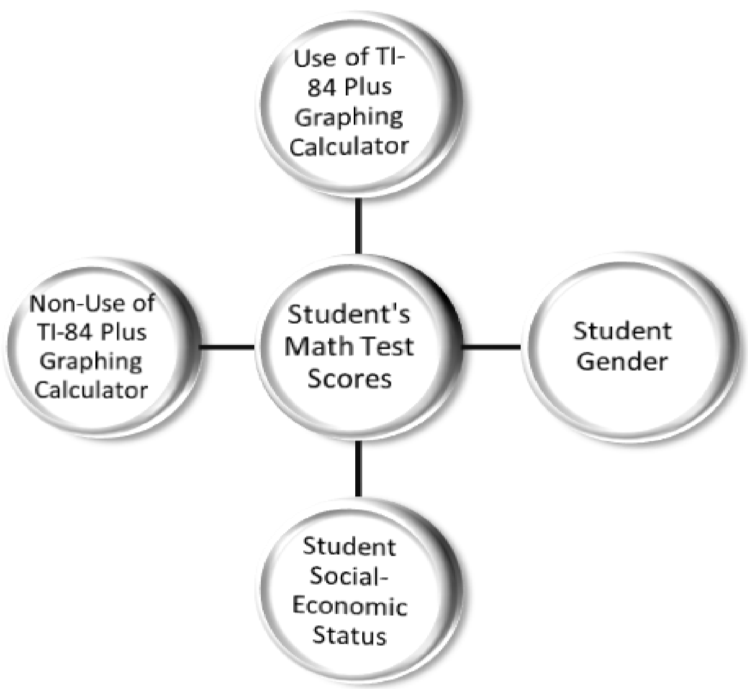


Figure 1. Relating the independent and dependent variables.

Cognitive development is the means of developing intellect and progressively advanced critical thinking capability from childhood to adulthood.

Constructivism is the theory of knowledge that claims that students produce meaning and knowledge from an interaction between their ideas and their experiences.

Constructivist classroom is a classroom that is grounded on the principle that learning happens when students are actively engaged the process of knowledge and meaning construction as opposed to inertly receiving information.

Constructivist teaching is teaching that is based on the principle that learning occurs as students are actively involved in a process of knowledge and meaning construction rather than passively receiving information.

Coordinate Algebra is a ninth grade mathematics course that aims to extend and formalize the mathematics knowledge that students acquired in middle school. The essential topics, prearranged into units, extend and deepen understanding of linear relationships, in part by contrasting them with exponential phenomena, and in part by applying linear models to data that exhibit a linear trend. Coordinate Algebra uses algebra to extend and deepen understanding of geometric concepts from middle school.

Curriculum-centered is the curriculum in which teacher role is dominant.

Developmental psychology is the branch of psychology concerned with the study of continuing behavioral transformations from birth until death.

Georgia End-of-Course Test (EOCT) is a test that was created to improve student achievement through effective instruction and assessment of the material in the state-mandated content standards. The EOCT program helps ensure that all Georgia students have access to rigorous courses that meet high academic expectations. The purpose of the EOCT is to provide diagnostic data that can be used to enhance the effectiveness of schools' instructional programs. The Georgia End-of-Course Testing program is a result of the A+ Educational Reform Act of 2000, O.C.G.A. §20-2-281. This act requires the Georgia Department of Education to create end-of-course assessments for students in grades 9 through 12 (Georgia Department of Education, 2015).

Georgia Milestones Assessment System (Georgia Milestones) is a comprehensive summative assessment program spanning grades 3 through high school that measures how well students have learned the knowledge and skills outlined in the state-adopted content standards in language arts, mathematics, science, and social studies. Students in grades 3 through 8 will take an end-of-grade assessment in each content area, while high school students will take an end-of-course assessment for each of the eight courses designated by the State Board of Education. Features of the Georgia Milestone Assessment System include:

- open-ended (constructed-response) items in language arts and mathematics (all grades and courses);
- a writing component (in response to passages read by students) at every grade level and course within the language arts assessment;
- norm-referenced items in all content areas and courses, to complement the criterion-referenced information and to provide a national comparison; and

- transition to online administration over time, with online administration considered the primary mode of administration and paper-pencil as back-up until the transition is complete (Georgia Department of Education, 2015).

Learner-centered is the method of focusing on student's interests, rather than those of others involved in the educational practice, such as administrators and teachers.

Meaning maker is when the learner is capable of understanding meaning.

Progressive education is a comprehensive drive for educational transformation and is predominantly associated with John Dewey, but encompasses many conflicting and different and philosophies. The term "progressive" was employed to observe education from the established curriculum of the 19th century, which was strongly differentiated by socioeconomic status and rooted in classical preparation for the university. Progressive educators regard existing schools as too formal, rigid, and isolated from real life experiences. Progressive educators prefer nonformal classroom procedures, nonformal relationships between teachers and students, and prefer schools to teach meaningful courses and stress "learning by doing" rather than traditional instruction procedures.

Project method is the teaching method by which students acquire knowledge through the planning and execution of practical projects. The project method originated in the second half of the 19th century in US schools. The project method was based on pragmatic teaching methods and was elaborated by John Dewey (1916). In the 1960s and 1970s, widespread criticism of the method arose in the United States as a result of the method's unsystematic approach and the decreased emphasis on the theoretical knowledge of the fundamentals of science in public schools.

Scaffolding is a collection of instructional methods employed to shift students increasingly toward deeper knowledge and more independence in the learning process.

Schemas illustrate an organized pattern of behavior or thought that organizes categories of knowledge and the connections between them.

Self-regulation is a learning process that comprises the development of a collection of constructive behaviors that influence learning. These processes are adapted and planned to sustain the pursuit of individual goals in varying learning environments. Self-regulation is a critical competency that underlies the thoughtful, intentional, and mindful behaviors of students. The term self-regulation refers to the ability to control one's impulses, both to stop doing something and to start doing something. Self-regulation is not to be confused with obedience or compliance; when students are truly self-regulated they act the same way whether or not a teacher is present.

Technology is the construction, usage, modification, and knowledge of machines, tools, crafts, systems, techniques, and means of configuration, in order to answer a problem, adjust a pre-existing solution to a problem, achieve a goal, manage a directed input/output relation, or perform a distinctive function.

TI-84 plus Graphing Calculator is a class of handheld scientific calculators that is capable of solving simultaneous equations, performing numerous other tasks with variables and plotting graphs.

Twelve principles of constructivist teaching are the principles that brain-compatible teaching is based upon.

Zone of proximal development is defined as the distance between the levels of potential development as determined through problem solving under adult guidance or in collaboration with capable peers and the actual development level as determined by independent problem solving.

Relationship among Variables

A study conducted by the Office of Program Evaluation (OPE) (2009) indicated that students in the 12th grade who used graphing calculators daily scored on average 9% higher on mathematics' assessments than students who did not use graphing calculators daily. Research suggests that the incorporation of graphing calculators in the mathematics curriculum may positively affect students' problem solving skills and ultimately raise student achievement in mathematics. Heller (2005) conducted an analysis that confirms student enjoyment in mathematics increases with the inclusion of graphing calculators.

Spelke (2008) discovered that there is a 30 point difference, in favor of the males, in all of the mathematics scores of girls and boys on the Scholastic Achievement Test (SAT). According to Spelke (2008), boys are more likely to be admitted into advanced mathematics programs if the SAT math test is the sole factor. Benbow and Stanley (cited in Spelke, 2008) also piloted a similar study that revealed 67% of the students that took the mathematics part of the SAT and scored at least a 500, were boys. The differences between male and female students' scores on achievement tests, as measured by scores on the ACT college readiness assessment, are less consistent than the differences seen in student course grades. Even though female students outperform male students in language arts and social sciences and the overall ACT composite scores of males and females are similar, the male students have superior achievement levels on both the math and science portions of the ACT. Dix (2005) conducted a study on boys and girls in the eighth grade using technology via geometry's sketch pad as a treatment for the experimental group and paper and pencil for the control group and administered an attitudinal survey. The findings of Dix's survey showed a substantial difference in which boys and girls view technology and reveals that both boys and girls think positively of technology. Nevertheless, an examination of the survey findings discloses that boys think more optimistically of technology than girls. Dix's (2005) findings also revealed that via technology, girls can advance reasoning on mathematical problems, thus giving girls additional motivation to achieve just as much or conceivably more than the boys on mathematics assessments.

According to Lubienski (2007), socioeconomically disadvantaged students struggle comprehending many mathematical theories that are discussed and students of a higher socioeconomic status are often intrinsically motivated to learn the mathematical concepts whether a teacher is present or not. Lubienski's research implied that the lower socioeconomic status students often tell the instructor "tell me the answer," and "how do you do it?" without making any attempts to discover the answers for themselves. Lubienski argued that students of a lower socioeconomic status are rapidly confused and are not certain if they are accurately answering questions, while students of a higher socioeconomic status habitually discern that the same mathematical concepts are repeated in various ways. Heller (2005) conducted an analysis that confirms student enjoyment in mathematics increases with the inclusion of graphing calculators. As with other studies, the contribution of these calculators not only allows these students to enjoy mathematics, but also achieve at levels much higher than normally associated with their SES. Heller stated that graphing calculators are used as a strategy to improve mathematics scores with students in Texas who are failing state assessments. Heller (2005) observed that calculators are introduced as a strategy to raise test scores and close achievement gaps in high poverty schools. Researchers have established that the addition of graphing calculators is a possible tactic to increase student achievement and close achievement gaps.

Even though some research suggest that upgrading in quality is connected with significant improvement in student achievement, research has yet to identify which teacher characteristics are most suggestive of quality. For example, measurable teacher attributes such as gender, race, years of teaching experience or education history, only account for 3% of a teacher’s influence on student achievement and a teacher’s years of experience is not substantially linked to student achievement. However, research confirms a strong connection between great attendance and student achievement and poor attendance has been linked to poor student achievement (Jones, 2006).

Limitations of the Study

A possible limitation to this experimental research was the sample size of 49 students. Any sample size less than a hundred can affect the variability, which is determined by the standard deviation of the population of students. The standard deviation of a sample is how far the true scores are from the scores of the collected sample of students. Ideally, the sample size of students should be as large as possible; the larger the standard deviation, the less accurate the results and smaller sample sizes tend to yield large standard deviations.

Another limitation was that the intervention was made without blinding the researcher to the experimental group, which had the potential for bias. However, potential bias was minimized by random assignment of participants. Lastly, the Hawthorne Effect (*The Economist*, 2009) is an inevitable bias that the researcher must try to take into consideration when the results are analyzed. The Hawthorne Effect is a well-documented occurrence that affects many research experiments. It is the process where the participants of an experiment alter their behavior, simply because they are being studied and is one of the most difficult inherent biases to remove.

Summary

Even though many are troubled about the lack of success in mathematics education, constructivism has a convincing influence in its present-day dialogue. Constructivism creates a distinct pathway between the concept of mathematics as facts to be transmitted to the student: the main ideas that have influenced how mathematics has been taught, and the belief that some students know mathematics and some students do not, where the educator's mission is to figure out how capable students are and select the appropriate assignments for them to perform.

Constructivism centers on how students acquire knowledge and suggests that mathematics knowledge results from students creating experiences in response to the challenges and obstacles that come from actively involving mathematics problems and not from solely receiving knowledge. The challenge in constructivist teaching is to create relevant experiences that engage students and support their own application, explanation, evaluation, and communication of mathematical concepts needed to make sense of their experiences.

Utilizing the constructivist theory in teaching necessitates great effort on the part of the instructor, and it also commands the learners to work in an active approach. The practice of constructivism reduces the load of the instructor being the only disseminator of new knowledge and swaps the role of the instructor into being the facilitator and not the main source of acquiring new knowledge. This experimental research is based on the constructivist theory of learning and how the use of the graphing calculator effects Coordinate Algebra student's achievement in mathematics.

CHAPTER IV

METHODOLOGY

Chapter four contains a description of the research design, methodology, the sampling procedures, the procedures for data collection, the plan for analysis of the data collected, and the TI-84 Plus Graphing Calculator professional learning experience for teachers of mathematics. The purpose of this experimental research is to determine the effectiveness of using the TI-84 Plus Graphing Calculator on students mastering Coordinate Algebra based on the district's posttest scores and to determine whether there is a relationship between the use of the TI-84 Plus Graphing Calculator and socioeconomic status on students' test scores. The results of this experimental research will be helpful for urban school districts and other school districts throughout the United States in determining the best method to incorporate graphing calculators into the teaching of mathematics in a high school setting.

Research Questions and Hypotheses

RQ1: Is there a statistically significant difference between the posttest scores of the control group and the posttest scores of the experimental group?

HO1. There will be a statistically significant difference between the posttest scores of the control group and the posttest scores of the experimental group.

RQ2: Is there a statistically significant difference between the pretest scores and posttest scores of the experimental group?

HO2. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the experimental group.

RQ3: Is there a statistically significant difference between the pretest scores and posttest scores of the control group?

HO3. The nonuse of TI-84 Plus Graphing Calculator will not have a significant effect on the posttest scores of the control group.

RQ4: Is there a statistically significant difference between the gain scores of the control group and the gain scores of the experimental group?

HO4. Students taught mathematics using the TI-84 Plus Graphing Calculator will score have a higher score gain on the posttest than students who do not use the TI-84 Plus Graphing Calculator.

RQ5: Is there a statistically significant difference between the pretest scores and posttest scores of the males in the experimental group?

HO5. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the males in the experimental group.

RQ6: Is there a statistically significant difference between the pretest scores and posttest scores of the females in the experimental group?

HO6. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the females in the experimental group.

RQ7: Is there a statistically significant difference between the pretest scores and posttest scores of the males in the control group?

HO7. The non-use of TI-84 Plus Graphing Calculator will not have a significant effect on the posttest scores of the males in the control group.

RQ8: Is there a statistically significant difference between the pretest scores and posttest scores of the females in the control group?

HO8. The nonuse of TI-84 Plus Graphing Calculator will not have a significant effect on the posttest scores of the females in the control group.

RQ9: Is there a statistically significant difference between the pretest scores and posttest scores of the students who receive free/reduced lunch in the experimental group?

HO9. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the students who receive free/reduced lunch in the experimental group.

RQ10: Is there a statistically significant difference between the pretest scores and posttest scores of the students who receive free/reduced lunch in the control group?

HO10. The nonuse of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the students who receive free/reduced lunch in the control group.

RQ11: Is there a statistically significant relationship between attendance and the posttest scores of the students in the experimental group?

HO11. The students in the experimental group with an attendance rate of a least 86% will score higher on the posttest than students who have an attendance rate less than 86%.

RQ12: Is there a statistically significant relationship between attendance and the posttest scores of the students in the control group?

HO12. The students in the control group with an attendance rate of a least 86% will score higher on the posttest than students who have an attendance rate less than 86%.

RQ13: Is there a statistically significant relationship between the perception of the impact of utilizing the TI-84 Plus Graphing Calculator and the gain scores of the students in the experimental group?

HO13. The students in the experimental group who have a positive perception of the impact of utilizing the TI-84 Plus Graphing Calculator will have a higher score gain than the students who did not have a positive perception.

Population and Samples

The participants for this experimental research consisted of two groups for comparison purposes and made up of a sample of regular education students who are in their freshman year in a Georgia metropolitan school district. The metropolitan school district has an active enrollment of almost 50,000 students, attending a total of 80 schools: 58 elementary (K-5), 3 of which operate on a year-round calendar; 12 middle (6-

8); 10 high (9-12) and 7 charter schools (Georgia Department of Education, 2006). The school system also supports two alternative schools for middle and/or high school students, two community schools, and an adult learning center. Based on the state Full-Time Equivalent (FTE) report from March of 2014 (Georgia Department of Education, 2014), the metropolitan school district has a total high school population of 12,387 students of which 6,548 were female and 5,839 were male. Based on the data obtained from the FTE report (Georgia Department of Education, 2014), the number of female students enrolled in grades 9, 10, 11, and 12 were as follows: 2,019, 1, 646, 1,540, and 1,343. The ethnic breakdown for females by grade level is as follows: grade 9: 8 Asian, Pacific Islander, 1,873 African Americans, 59 Hispanics, 11 Multiracial, 68 Caucasian; grade 10: 6 Asian, Pacific Islander, 1,539 African Americans, 23 Hispanics, 12 Multiracial, 66 Caucasian; grade 11: 9 Asian, Pacific Islander, 1,432 African Americans, 29 Hispanics, 8 Multiracial, 62 Caucasian; grade 12: 1 American Indian\Alaskan Native, 7 Asian, Pacific Islander, 1,260 African Americans, 19 Hispanics, 3 Multiracial, 53 Caucasian. Based on the data obtained from the FTE report (Georgia Department of Education, 2014), the number of male students enrolled in grades 9, 10, 11, and 12 are as follows: 2,085,1,491,1,228,1,035. The ethnic breakdown for males by grade level is as follows: grade 9: 7 Asian, Pacific Islander, 1,931 African Americans, 58 Hispanics, 9 Multiracial, 80 Caucasian; grade 10: 13 Asian, Pacific Islander, 1,365 African Americans, 51 Hispanics, 4 Multiracial, 58 Caucasian; grade 11: 3 Asian, Pacific Islander, 1,134 African Americans, 29 Hispanics, 4 Multiracial, 58 Caucasian; grade 12: 1 American Indian\Alaskan Native, 5 Asian, Pacific Islander, 946 African Americans, 18

Hispanics, 3 Multiracial, 62 Caucasian. There are 10,789 high school students who are classified as receiving free and\or reduced lunch.

This experimental research had 49 students from a high school in the large metropolitan school district in which 23 were female and 26 were male. All of the student participants in this experimental research were classified as receiving free and\or reduced lunch. The ethnic breakdown of the students is as follows: 0 Caucasian, 0 Asian, 0 Hispanics, and 49 African-Americans. The control group contained 24 students of which 11 were female and 13 were male. The ethnic breakdown of the control group is as follows: 0 Caucasian, 0 Asian, 0 Hispanics, and 24 African Americans. The 24 students in the control group were classified as receiving free and\or reduced lunch. The experimental group contained 25 students of which 12 were female and 13 were male. The ethnic breakdown of the experimental group is as follows: 0 Caucasian, 0 Asian, and 25 African Americans. The 25 students in the experimental group were classified as receiving free and\or reduced lunch.

The samples in this experimental research were randomly selected from a high school in the large metropolitan school district and consisted of an experimental group of students whose teacher participated in a TI-84 Plus Graphing Calculator professional learning experience and a control group of students who have the same teacher but did not receive the intervention. All the student participants selected had a ninth grade classification. The experimental group learned Coordinate Algebra utilizing the TI-84 Graphing Calculator (The TI-84 Graphing Calculator is not a required tool by the state of Georgia or the metropolitan school district). The registrar, using the registrar's computer program, Infinite Campus, randomly assigned the students to both the control group and experimental group.

The teacher for both the experimental group and the control group was selected solely on a voluntary basis through self-nomination. The teacher had received high-quality, hands-on professional development at the 2015 NCTM Annual Meeting and Exposition from experienced TI instructors with track records of classroom success and proven strategies for implementing TI's exam-accepted technology and standards aligned activities in the high school mathematics classroom. The professional development enhanced both the understanding and application of the following:

- Instructional practices that promote students' depth of knowledge and balance conceptual understanding, procedural fluency and application
- Content knowledge that challenges math students to reason, justify and explain their thinking
- TI technology to facilitate students' progression from conceptual understanding to strategic, extended thinking.

In the experimental group, the teacher utilized Coordinate Algebra lessons developed by Texas Instruments provided during the professional development training. Each week, the teacher utilized TI-84 Graphing Calculator lessons to teach Coordinated Algebra for the experimental group. The teacher continued to utilize traditional methodology of teaching mathematics for the control group. All classes adhered to the established school district course of study, used the same textbooks, and received the same body of content knowledge. All of the Coordinate Algebra students took a common pretest assessment, created by the metropolitan school district, during the first week of the semester. Near the end of the first quarter of the semester, the Coordinate Algebra students took a common posttest assessment, created by the metropolitan school district, to determine whether the TI-84 Plus Graphing Calculator increased the probability of the students passing the Coordinate Algebra Georgia Milestone Assessment.

According to the Georgia Department of Education (2014), student performance on the Georgia Milestone Assessment will be used for accountability and for measuring the quality of education in the state. The Georgia Milestone Assessment is the final exam for a Georgia Milestone Assessment course. According to the Georgia Department of Education, student's final grade in the course should be calculated using the course grade as 80% and the Georgia Milestone Assessment score as 20% of the final grade. In essence, students must have a final grade of 70 or better to pass the course and to earn credit toward graduation. Based on the Georgia Department of Education, students' performance on the Georgia Milestone Assessment is based on the number of correct items which is converted to scale scores. In previous years, each time the EOCT was administered, a new form of the test was equated with previously administered forms to adjust for differences in difficulty, and the scores on the different forms share the same reporting scale (Georgia Department of Education, 2014). The EOCT scores were reported on a scale that ranged from 400 to 950. According to the Georgia Department of Education, for all subjects, the cut score that indicated a student is meeting the EOCT standard was 600 and the cut score that indicate a student was exceeding standard was

630. In addition to a scale score for each test, a grade conversion scale, ranging from 0 to 100, described student performance on an EOCT (Georgia Department of Education, 2014). A student had to achieve a grade conversion scale of 70 in order to pass the EOCT.

Similar to the EOCT, The Georgia Milestones Assessment System measures how well students have learned the knowledge and skills outlined in the state-adopted content standards. Features the Georgia Milestone Assessment System include:

I. Open-ended (constructed-response) items in language arts and mathematics (all grades and courses);

II. A writing component (in response to passages read by students) at every grade level and course within the language arts assessment;

III. Norm-referenced items in all content areas and courses, to complement the criterion-referenced information and to provide a national comparison; and

IV. Transition to online administration over time, with online administration considered the primary mode of administration and paper-pencil as back-up until the transition is complete (Georgia Department of Education, 2015).

TI-84 Plus Graphing Calculator Professional Learning Experience Treatment

The teacher of the experimental group had received high-quality, hands-on professional development at the 2015 NCTM Annual Meeting and Exposition from experienced TI instructors with track records of classroom success and proven strategies for implementing TI's exam-accepted technology and standards aligned activities in the high school mathematics classroom, prior to this experimental research. The professional development enhanced both the understanding and application of the following:

- Instructional practices that promote students' depth of knowledge and balance conceptual understanding, procedural fluency and application
- Content knowledge that challenges math students to reason, justify and explain their thinking
- TI technology to facilitate students' progression from conceptual understanding to strategic, extended thinking

Professional development and training for the participants was administered prior to the pretest. The professional development and training consisted of two one hour sessions in which the participants were informed on utilizing the TI-84 Plus Graphing Calculator and the participants were trained on how to use the TI-84 Plus Graphing Calculator. The professional development training sessions described the topic of the TI-84 Plus Graphing Calculators' Coordinate Algebra Lesson, curriculum, the critical preparation, planning, prerequisite and structural plans, and responsibilities of the mathematics instructor. The professional development also incorporated classroom preparation, teaching strategies, schedules and times of TI-84 Plus Graphing Calculator activities, an inventory of all necessary equipment and classroom management strategies. The professional learning experience summarized what the teacher needs to know about implementing TI-84 Plus Graphing Calculators in teaching Coordinate Algebra into classroom settings. Also, the teacher was provided a suggested schedule, advance preparation, objectives, equipment needed, assumptions of prior knowledge, and teaching sequence preview. To ensure that the teacher was properly utilizing the TI-84 Plus Graphing Calculator algebra lessons consistently, the teacher was provided detailed instructions for teaching the four phases of the learning experience: setting the context, experimenting and investigating, processing for meaning, and applying. The TI-84 Plus Graphing Calculator professional learning experience provided the teacher with teaching strategies such as suggestions to facilitate students toward acquiring new knowledge, tips on what to look for while circulating among groups, and discussion questions.

Data Collection

To determine whether instruction utilizing the TI-84 Plus Calculators had a greater impact on students mastering Coordinate Algebra content versus the traditional method of teaching mathematics, data were collected utilizing the district's pretest and posttest. The pretest was administered to the students during the first week of the school year and the posttest was administered at the end of the first quarter of the semester. The data on the students' performance on the pretest and posttest in Coordinate Algebra was obtained from the district's office of research and accountability.

As part of documentation, the researcher developed and maintained weekly journals and logs from both the teacher and the students to create ongoing records about what they were doing and learning in Coordinate Algebra and maintained a chronological record of their learning experiences. The researcher also solicited the direct supervisor of the teacher to observe both the control and experimental groups and provide feedback for additional documentation.

Research Design

Figure 2 represents the comparison group pretest/posttest design for this experimental research. The steps in the classic controlled experiment were:

1. The subjects were randomly assigned to the treatment or control group.
2. The pretest was administered to all subjects in both groups.
3. A safeguard was that both groups underwent the same circumstances except that in addition, the experimental group experienced the treatment.
4. The posttest was administered to all subjects in both groups.
5. The researcher assessed the amount of change on the value of the dependent variable from the pretest to the posttest for each group separately.

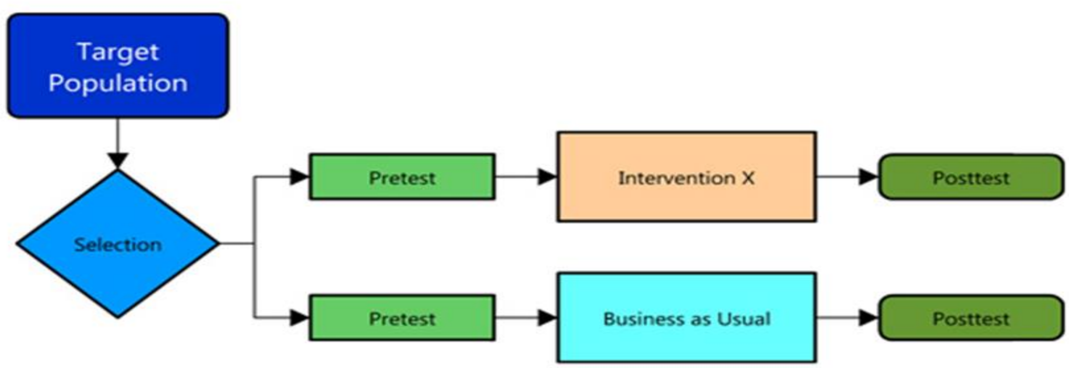


Figure 2. *Comparison group pretest/posttest design.*

Instrumentation

The data for this experimental research were collected using the district's pre and post Coordinate Algebra Exam. The exam consisted of 30 questions. The students' performance levels for this test consisted of three levels: does not meet, meets, and exceeds.

Statistical Application/Data Analysis

Research questions 1, 2, 3, 5, 6, 7, 8, 9, and 10 were analyzed utilizing a paired sample *t*-test for comparison of means. The mean score was calculated for all the students in the control group and for all the students in the experimental group. The paired sample *t*-test was used because those eight questions involve a repeated measure design. According to Easton and McColl (2006), a paired sample *t*-test is used to determine whether there is a significant difference between the average values of the same measurement made under two different conditions. Based on the work of Ganter (2014), a paired sample t-test should be used instead of a regular comparison of the sample means because a paired sample t-test reduces bias and increases precision. Also, an independent t-test was used in this experimental research to answer the first and fourth research question. Ravid's (2005) work reveals that an independent t-test is used to compare two sample means that are independent of one another.

The 11th, 12th, and 13th research questions were analyzed utilizing Pearson *r*. Based on the works of Price and Oswald (2006), Pearson's correlation is used when there are two quantitative variables and the research hypothesis predicts whether there is a linear relationship between these two quantitative variables. In essence, correlation between sets of data is a measure of how well they are related. The results will be between -1 and 1. According to Price and Oswald, one will rarely observe 0, -1 or 1. One will obtain a number somewhere in between those values. The closer the value of r gets to zero, the greater the variation the data points are around the line of best fit.

Summary

The purpose of this experimental research was to determine the effectiveness of using the TI-84 Plus Graphing Calculator on students mastering Coordinate Algebra based on the district's posttest scores and to determine whether there is a relationship between the use of the TI-84 Plus Graphing Calculator and students' test scores. Chapter III presented the rationale for the study with a detailed definition of the variables identified and measured for the purpose of generating the appropriate findings and conclusions for this experimental research. The context is described and the details of data collection were also presented. The next two chapters present the results, findings, interpretation, discussion, and conclusions from the experimental research. Chapter V presents the results of both the qualitative and quantitative data collected. Chapter VI presents a discussion of the results, the conclusions, recommendations, and suggestions for further consideration and future research.

CHAPTER V

DATA ANALYSIS

Chapter five presents an analysis of the data and the research questions that guided this experimental research. The purpose of this experimental research was to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment. Both the demographic information about the participants and the hypotheses are discussed in this chapter.

Demographic Analysis

The participants for this experimental research consisted of two groups for comparison purposes and made up of a sample of regular education students who are in their freshman year in a Georgia metropolitan school district. The metropolitan school district has an active enrollment of almost 50,000 students, attending a total of 80 schools: 58 elementary (K-5), 3 of which operate on a year-round calendar; 12 middle (6-8); 10 high (9-12) and 7 charter schools (Georgia Department of Education, 2006). The school system also supports two alternative schools for middle and/or high school students, two community schools, and an adult learning center. Based on the state Full-Time Equivalent (FTE) report from March of 2014 (Georgia Department of Education, 2014), the metropolitan school district has a total high school population of 12,387 students of which 6,548 were female and 5,839 were male. Table 3 presents the gender demographics of the Metropolitan High School District.

Table 3

Metropolitan High School District Demographics (Gender)

Gender	Number of Students	Percentage
Female	6,548	53%
Male	5,839	47%
Total	12,387	100%

Based on the data obtained from the FTE report (Georgia Department of Education, 2014), the number of female students enrolled in grades 9, 10, 11, and 12 were as follows: 2,019, 1, 646, 1,540, and 1,343. The ethnic breakdown for females by grade level is as follows: grade 9: 8 Asian, Pacific Islander, 1,873 African American, 59 Hispanic, 11 Multiracial, 68 Caucasian; grade 10: 6 Asian, Pacific Islander, 1,539 African American, 23 Hispanic, 12 Multiracial, 66 Caucasian; grade 11: 9 Asian, Pacific Islander, 1,432 African American, 29 Hispanic, 8 Multiracial, 62 Caucasian; grade 12: 1 American Indian\Alaskan Native, 7 Asian, Pacific Islander, 1,260 African American, 19 Hispanic, 3 Multiracial, 53 Caucasian.

Table 4 presents the number of female students enrolled in grades 9, 10, 11, and 12 in the Metropolitan High School District. Table 5 shows ninth grade female students' demographics in the Metropolitan High School District.

Table 4

Female Students Enrolled in the Metropolitan High School District

Grade Level	Number of Students	Percentage
9th Grade	2,019	31.0%
10th Grade	1,646	25.0%
11th Grade	1,540	23.5%
12th Grade	1,343	20.5%
Total	6,548	100.0%

Table 5

Ninth Grade Female Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
Asian/Pacific Islander	8	0.4%
African American	1,873	92.8%
Hispanic	59	2.9%
Multiracial	11	0.5%
Caucasian	68	3.4%
Total	2,019	100.0%

Table 6 presents the ethnic analysis of the 10^{th} grade female students.

Table 6

10th Grade Female Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
Asian/Pacific Islander	6	0.4%
African American	1,539	93.5%
Hispanic	23	1.4%
Multiracial	12	0.7%
Caucasian	66	4.0%
Total	2,019	100.0%

Table 7 presents the ethnic analysis of the 11th grade female students.

Table 7

11th Grade Female Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
Asian/Pacific Islander	9	0.6%
African American	1,432	93.0%
Hispanic	29	1.9%
Multiracial	8	0.5%
Caucasian	62	4.0%
Total	1,540	100.0%

Table 8 presents the ethnic analysis of the 12th grade female students.

Table 8

12th Grade Female Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
American Indian	1	0.07%
Asian/Pacific Islander	7	0.52%
African American	1,260	93.8%
Hispanic	19	1.42%
Multiracial	3	0.23%
Caucasian	53	3.96%
Total	1,343	100.0%

Based on the data obtained from the FTE report (Georgia Department of Education, 2014), the number of male students enrolled in grades 9, 10, 11, and 12 are as follows: 2,085,1,491,1,228,1,035. The ethnic breakdown for males by grade level is as follows: grade 9: 7 Asian, Pacific Islander, 1,931 African American, 58 Hispanic, 9 Multiracial, 80 Caucasian; grade 10: 13 Asian, Pacific Islander, 1,365 African American, 45 Hispanic, 4 Multiracial, 58 Caucasian; grade 11: 3 Asian, Pacific Islander, 1,134 African American, 29 Hispanic, 4 Multiracial, 58 Caucasian; grade 12: 1 American Indian\Alaskan Native, 5 Asian, Pacific Islander, 946 African-American, 18 Hispanic, 3 Multiracial, 62 Caucasian.

Table 9 presents the number of male students enrolled in grades 9, 10, 11, and 12 in the Metropolitan High School District.

Table 9

Male Students Enrolled in the Metropolitan High School District

Grade Level	Number of Students	Percentage
9th Grade	2,085	35.7%
10th Grade	1,491	25.5%
11th Grade	1,228	21.0%
12th Grade	1,035	17.8%
Total	5,839	100.0%

Table 10 presents the ethnic analysis of the 9th grade male students.

Table 10

Ninth Grade Male Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
Asian/Pacific Islander	7	0.34%
African American	1,931	92.6%
Hispanic	58	2.8%
Multiracial	9	0.43%
Caucasian	80	3.83%
Total	2,085	100.0%

Table 11 presents the ethnic analysis of the 10th grade male students.

Table 11

10th Grade Male Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
Asian/Pacific Islander	13	0.9%
African American	1,365	91.4%
Hispanic	51	3.4%
Multiracial	4	0.3%
Caucasian	58	4.0%
Total	1,491	100.0%

Table 12 presents the ethnic analysis of the 11th grade male students.

Table 12

11th Grade Male Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
Asian/Pacific Islander	3	0.24%
African American	1,134	92.34%
Hispanic	29	2.36%
Multiracial	4	0.33%
Caucasian	58	4.73%
Total	1,228	100.0%

Table 13 presents the ethnic analysis of the 12th grade male students.

Table 13

12th Grade Male Students' Demographics in the Metropolitan High School District

Race/Ethnicity	Number of Students	Percentage
American Indian	1	0.1%
Asian/Pacific Islander	5	0.5%
African American	946	91.4%
Hispanic	18	1.7%
Multiracial	3	0.3%
Caucasian	62	6.0%
Total	1,035	100.0%

There are 10,789 high school students who are classified as receiving free and\or reduced lunch. Table 14 presents the percentage of students in the Metropolitan High School District that receive free/reduced lunch.

Table 14

Students' Demographics (Free/Reduced) in the Metropolitan High School District

Free/Reduced Lunch	Number of Students	Percentage
Receive	10,789	87.0%
Does Not Receive	1,598	13.0%
Total	12,387	100.0%

This experimental research had a total of (N = 49) students in which 23 are female and 26 are male. Table 15 presents the demographics of the participants of the experimental research.

Table 15

Demographics of the Participants (Gender)

Gender	Number of Students	Percentage
Female	23	47.0%
Male	26	53.0%
Total	49	100.0%

All of the students are classified as receiving free and\or reduced lunch. The ethnic breakdown of the students is as follows: 0 Caucasian, 0 Asian, 0 Hispanic, and 49 African American. The control group had a total of 24 students of which 11 are female and 13 are male. Table 16 presents the demographics of the control group.

Table 16

Demographics of the Control Group (Gender)

Gender	Number of Students	Percentage
Female	11	46.0%
Male	13	54.0%
Total	24	100.0%

The ethnic breakdown of the control group is as follows: 0 Hispanics and 24 African Americans. The 24 students in the control group are classified as receiving free and\or reduced lunch. The experimental group has a total of 25 students of which 12 are female and 13 are male. Table 17 presents the demographics of the experimental group.

Table 17

Demographics of the Experimental Group (Gender)

Gender	Number of Students	Percentage
Female	12	44.0%
Male	13	56.0%
Total	25	100.0%

The ethnic breakdown of the experimental group is as follows: 0 Caucasian, Asian, and 25 African American. The 25 students in the experimental group are classified as receiving free and\or reduced lunch.

Analysis of the Data

The participants of both student groups (students utilizing the TI-84 Plus Graphing Calculator, students without the TI-84 Plus Graphing Calculator) were administered a Coordinate Algebra Pretest. Means and standard deviations are shown in Table 18. The Coordinate Algebra Milestones pretest yielded a total mean score of 32.76 (SD = 8.17). Results disaggregated by group membership yielded a mean pretest score of 31.00 (SD = 8.44) for the experimental group and 34.58 (SD =7.05) for the control group.

Table 18

Means and Standard Deviations for the Coordinate Algebra Milestones Pretest

Group	Mean Score	Standard Deviations	Size
Control Group	34.58	7.05	24
Experimental Group	31.00	8.44	25
Total Sample	32.76	8.17	49

An independent *t*-test was applied to the Coordinate Algebra Milestones pretest data to compare the experimental group and the control group for initial variations. Ravid’s (2005) work reveals that an independent *t*-test is used to compare two sample means that are independent of one another. In the analysis, the independent *t*-test results revealed no significant difference, t-value = 1.583834, $p = .059969$, at $p < .05$, between the means of both the control and experimental groups’ pretest scores.

RQ1: Is there a statistically significant difference between the posttest scores of the control group and the posttest scores of the experimental group?

This experimental research poses the following question: Is there a statistically significant difference between the posttest scores of the control group and the posttest scores of the experimental group? Research Question 1 was addressed by testing the following hypothesis:

HO1. There will be a statistically significant difference between the posttest scores of the control group and the posttest scores of the experimental group.

Means and standard deviations are shown in Table 19. The Coordinate Algebra Milestones posttest yielded a total mean score of 54.08 (SD = 13.64). Results disaggregated by group membership yielded a mean pretest score of 56.20 (SD = 12.01) for the experimental group and 51.90 (SD =15.09) for the control group.

Table 19

Means and Standard Deviations for the Coordinate Algebra Milestones Posttest for Both Groups

Group	Mean Score	Standard Deviations	Size
Control Group	51.90	15.09	24
Experimental Group	56.20	12.01	25
Total Sample	54.08	13.64	49

An independent t-test was applied to the Coordinate Algebra Milestones posttest data to compare the experimental group and the control group for final variations. In the analysis, the independent t-test results revealed no significant difference, t-value = 1.112084, $p = .271758$, at $p < .05$, between the means of both the control and experimental groups' posttest scores.

RQ2: Is there a statistically significant difference between the pretest scores and posttest scores of the experimental group?

Research Question 2 was addressed by testing the following hypothesis:

HO2. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the experimental group.

A paired sample t-test was applied to the Coordinate Algebra pretest and posttest data to the experimental group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 20). According to Easton and McColl (2006), a paired sample t-test is used to determine whether there is a significant difference between the average values of the same measurement made under two different conditions. Based on the work of Ganter (2014), a paired sample *t*-test should be used instead of a regular comparison of the sample means because a paired sample *t*-test reduces bias and increases precision. In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 8.841652, the value of p is < 0.0001 at p < 0.05, between the means of the pretest and posttest scores of the experimental group.

Table 20

Statistics for the Experimental Group's Pretest and Posttest Scores

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	31.0000	25	8.66025	1.73205
	Posttest	56.2000	25	12.01388	2.40278

Paired Samples Correlations for the Experimental Group's Pretest and Posttest Scores

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	25	.078	.711

Paired Samples Test for the Experimental Group's Pretest and Posttest Scores

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pretest & Posttest	25.20000	14.25073	2.85015	-31.08241	-19.31759	8.842	24	.000

RQ3: Is there a statistically significant difference between the pretest scores and posttest scores of the control group?

Research Question 3 was addressed by testing the following hypothesis:

HO3. The nonuse of TI-84 Plus Graphing Calculator will not have a significant effect on the posttest scores of the control group.

A paired sample *t*-test was applied to the Coordinate Algebra pretest and posttest data to the control group to determine if there is a statistically significant difference between the students' pretest and posttest scores. In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 6.506270, the value of p is < 0.0001 at p < 0.05, between the means of the pretest and posttest scores of the control group (see Table 21).

Table 21

Statistics for the Control Group's Pretest and Posttest Scores

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	34.5833	24	7.05825	1.44076
	Posttest	51.8750	24	15.09481	3.0812

Paired Samples Correlations for the Control Group's Pretest and Posttest Scores

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	24	.508	.011

(continued)

Table 21 (continued)

Paired Samples Test for the Control Group's Pretest and Posttest Scores

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pretest & Posttest	17.29167	13.01998	2.65769	-22.78952	-11.79381	6.506	23	.000

RQ4: Is there a statistically significant difference between the gain scores of the control group and the gain scores of the experimental group?

Research Question 4 was addressed by testing the following hypothesis:

HO4. Students taught mathematics using the TI-84 Plus Graphing Calculator will score have a higher score gain on the posttest than students who do not use the TI-84 Plus Graphing Calculator.

An independent *t*-test was applied to the gain scores of the control group and the gain scores of the experimental group. In the analysis, the independent *t*-test results revealed a significant difference, t-value = 2.1412, $p = .037474$, at $p < .05$, between the means of the gain scores of both the control group and the experimental group.

RQ5: Is there a statistically significant difference between the pretest scores and posttest scores of the males in the experimental group?

Research Question 5 was addressed by testing the following hypothesis:

HO5. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the males in the experimental group.

A paired *t*-test was applied to the Coordinate Algebra Milestones pretest and posttest data to the males in the experimental group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 22). In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 7.479003, the value of p is < 0.0001 at p < 0.05, between the means of the pretest and posttest scores of the males in the experimental group.

Table 22

Statistics for the Males in the Experimental Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	28.0769	13	8.04634	2.23165
	Posttest	54.2308	13	10.57634	2.93335

Paired Samples Correlations for the Males in the Experimental Group

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	13	.104	.736

Paired Samples Test for the Males in the Experimental Group

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest & Posttest	26.15385	12.60850	3.49697	-33.77309	-18.53460	7.479	12	.000

RQ6: Is there a statistically significant difference between the pretest scores and posttest scores of the females in the experimental group?

Research Question 6 was addressed by testing the following hypothesis:

HO6. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the females in the experimental group.

A paired sample *t*-test was applied to the Coordinate Algebra Milestones pretest and posttest data to the females in the experimental group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 23). In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 5.619019, the value of p is 0.000156 at $p < 0.05$, between the means of the pretest and posttest scores of the females in the experimental group.

Table 23

Statistics for the Females in the Experimental Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	34.1667	12	8.48350	2.44897
	Posttest	58.3333	12	13.54006	3.90868

Paired Samples Correlations for the Females in the Experimental Group

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	12	.145	.653

Paired Samples Test for the Females in the Experimental Group

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest & Posttest	24.16667	14.89865	4.30087	-33.63282	-14.70052	5.619	11	.000

RQ7: Is there a statistically significant difference between the pretest scores and posttest scores of the males in the control group?

Research Question 7 was addressed by testing the following hypothesis:

HO7. The nonuse of TI-84 Plus Graphing Calculator will not have a significant effect on the posttest scores of the males in the control group.

A paired sample *t*-test was applied to the Coordinate Algebra Milestones pretest and posttest data to the males in the control group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 24). In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 4.462874, the value of p is 0.000775 at $p < 0.05$, between the means of the pretest and posttest scores of the males in the control group.

Table 24

Statistics for the Males in the Control Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	31.9231	13	4.34859	1.20608
	Posttest	46.5385	13	12.48075	3.46154

Paired Samples Correlations for the Males in the Control Group

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	13	.325	.279

Paired Samples Test for the Males in the Control Group

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pretest & Posttest	14.61538	11.80775	3.27488	-21.75074	-7.48003	4.463	12	.000

RQ8: Is there a statistically significant difference between the pretest scores and posttest scores of the females in the control group?

Research Question 8 was addressed by testing the following hypothesis:

HO8. The nonuse of TI-84 Plus Graphing Calculator will not have a significant effect on the posttest scores of the females in the control group.

A paired sample *t*-test was applied to the Coordinate Algebra Milestones pretest and posttest data to the females in the control group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 25). In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 4.769990, the value of p is 0.000757 at $p < 0.05$, between the means of the pretest and posttest scores of the females in the control group.

Table 25

Statistics for the Females in the Control Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	37.7273	11	8.47456	2.55518
	Posttest	58.1818	11	16.01136	4.82761

Paired Samples Correlations for the Females in the Control Group

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	11	.464	.151

(continued)

Table 25 (continued)

Paired Samples Test for the Females in the Control Group

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest & Posttest	20.45455	14.22226	4.28817	-30.00919	-10.89990	4.770	10	.001

RQ9: Is there a statistically significant difference between the pretest scores and posttest scores of the students who receive free/reduced lunch in the experimental group?

Research Question 9 was addressed by testing the following hypothesis:

HO9. The use of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the students who receive free/reduced lunch in the experimental group.

A paired sample *t*-test was applied to the Coordinate Algebra pretest and posttest data to the student who receive free/reduced lunch in the experimental group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 26). In the analysis, the paired sample t-test results revealed a significant difference, t-value = 8.841652, the value of p is < 0.0001 at $p < 0.05$, between the means of the pretest and posttest scores of the students who receive free/reduced lunch in the experimental group.

Table 26

Statistics for the Students who Receive Free/Reduced Lunch in the Experimental Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	31.0000	25	8.66025	1.73205
	Posttest	56.2000	25	12.01388	2.40278

Paired Samples Correlations for the Students who Receive Free/Reduced Lunch in the Experimental Group

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	25	.078	.711

Paired Samples Test for the Students who Receive Free/Reduced Lunch in the Experimental Group

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pretest & Posttest	25.20000	14.25073	2.85015	-31.08241	-19.31759	8.842	24	.000

RQ10: Is there a statistically significant difference between the pretest scores and posttest scores of the students who receive free/reduced lunch in the control group?

Research Question 10 was addressed by testing the following hypothesis:

HO10. The nonuse of TI-84 Plus Graphing Calculator will have a significant effect on the posttest scores of the students who receive free/reduced lunch in the control group.

A paired sample *t*-test was applied to the Coordinate Algebra pretest and posttest data to the students who receive free/reduced lunch in the control group to determine if there is a statistically significant difference between the students' pretest and posttest scores (see Table 27). In the analysis, the paired sample *t*-test results revealed a significant difference, t-value = 6.506270, the value of p is < 0.0001 at p < 0.05, between the means of the pretest and posttest scores of the students who receive free/reduced lunch in the control group.

Table 27

Statistics for the Students who Receive Free/Reduced Lunch in the Control Group

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	34.5833	24	7.05825	1.44076
	Posttest	51.8750	24	15.09481	3.08121

Paired Samples Correlations for the Students who Receive Free/Reduced Lunch in the Control Group

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	24	.508	.011

Paired Samples Test for the Students who Receive Free/Reduced Lunch in the Control Group

	Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper	t	Df	Sig. (2-tailed)
Pretest & Posttest	17.29167	13.01998	2.65769	-22.78952	-11.79381	6.506	23	.000

RQ11: Is there a statistically significant relationship between attendance and the posttest scores of the students in the experimental group?

Research Question 11 was addressed by testing the following hypothesis:

HO11. The students in the experimental group with an attendance rate of a least 86% will score higher on the posttest than students who have an attendance rate less than 86%.

The 11th research question was analyzed by utilizing Pearson *r* (see Table 28). Based on the works of Price and Oswald (2006), Pearson's correlation is used when there are two quantitative variables and the research hypothesis predicts whether there is a linear relationship between these two quantitative variables. In essence, correlation between sets of data is a measure of how well they are related. The results will be between -1 and 1. According to Price and Oswald, one will rarely observe 0, -1 or 1. One will obtain a number somewhere in between those values. The closer the value of r gets to zero, the greater the variation the data points are around the line of best fit. The value of *r* in analyzing the 11th research question is 0.7464. This is a significant positive correlation, which means there is a tendency for a high X variable (Attendance rate) to go with a high Y variable (Posttest scores). The value of r squared, the coefficient of determination, is 0.5571.

Table 28

Statistics for the Attendance vs. Posttest Scores for the Experimental Group

	Mean	N	Std. Deviation	Std. Error Mean
Attendance	14.2000	25	1.04083	.20817
Posttest	56.2000	25	12.01388	2.40278

Pearson r Correlations for the Attendance vs. Posttest Scores for the Experimental Group

	N	Correlation	Sig.
Attendance vs. Posttest	25	.746	.001

RQ12: Is there a statistically significant relationship between attendance and the posttest scores of the students in the control group?

Research Question 12 was addressed by testing the following hypothesis:

HO12. The students in the control group with an attendance rate of a least 86% will score higher on the posttest than students who have an attendance rate less than 86%.

The 12th research question was analyzed by utilizing Pearson *r* (see Table 29). The value of *r* in analyzing the 12th research question is 0.6774. This is a significant positive correlation, which means there is a tendency for a high X variable (attendance rate) to go with a high Y variable (posttest scores). The value of r squared, the coefficient of determination, is 0.4589.

Table 29

Statistics for the Attendance vs. Posttest Scores for the Control Group

	Mean	N	Std. Deviation	Std. Error Mean
Attendance	14.0417	24	1.26763	.25875
Posttest	51.8750	24	15.09481	3.08121

Pearson r Correlations for the Attendance vs. Posttest Scores for the Experimental Group

	N	Correlation	Sig.
Attendance vs. Posttest	24	.677	.000

RQ13: Is there a statistically significant relationship between the perception of the impact of utilizing the TI-84 Plus Graphing Calculator and the gain scores of the students in the experimental group?

Research Question 13 was addressed by testing the following hypothesis:

HO13. The students in the experimental group who have a positive perception of the impact of utilizing the TI-84 Plus Graphing Calculator will have a higher score gain than the students who did not have a positive perception.

The 13th research question was analyzed by utilizing Pearson *r* (see Table 30). The value of *r* in analyzing the thirteenth research question is 0.5687. This is a significant positive correlation, which means there is a tendency for a high X variable (Perception) to go with a high Y variable (Posttest scores). The value of *r* squared, the coefficient of determination, is 0.3234.

Table 30

Statistics for the Perception vs. Posttest Scores for the Experimental Group

	Mean	N	Std. Deviation	Std. Error Mean
Perception	2.6000	25	.70711	.14142
Posttest	25.6000	25	14.09196	2.81839

Pearson r Correlations for the Perception vs. Posttest Scores for the Experimental Group

	N	Correlation	Sig.
Perception vs. Posttest	25	.569	.003

Summary

This chapter presented a description of the participating students. Following the descriptive data, the research questions and related hypotheses were examined. Of the hypotheses testing using a paired sample *t*-test and Pearson *r* Correlations, 7 of the 13 were found to be significantly correlated with utilizing the TI-84 Plus Graphing Calculator. In the analysis of the second research question, the paired sample *t*-test results revealed a significant difference, t-value = 8.841652, the value of p is < 0.0001 at

$p < 0.05$, between the means of the pretest and posttest scores of the experimental group. In the analysis of the fourth research question, the independent *t*-test results revealed a significant difference, t-value = 2.1412, $p = .037474$, at $p < .05$, between the means of the gain scores of both the control group and the experimental group. In the analysis of the fifth research question, the paired sample *t*-test results revealed a significant difference, t-value = 7.479003, the value of p is < 0.0001 at $p < 0.05$, between the means of the pretest and posttest scores of the males in the experimental group. In the analysis of the sixth research question, the paired sample *t*-test results revealed a significant difference, t-value = 5.619019, the value of p is 0.000156 at $p < 0.05$, between the means of the pretest and posttest scores of the females in the experimental group. In the analysis of the ninth research question, the paired sample t-test results revealed a significant difference, t-value = 8.841652, the value of p is < 0.0001 at $p < 0.05$, between the means of the pretest and posttest scores of the students who receive free/reduced lunch in the experimental group. In analysis of the 11th research question, the value of the Pearson r Correlation Coefficient is 0.7464. This is a significant positive correlation, which means there is a tendency for a high X variable (Attendance rate) to go with a high Y variable (Posttest scores). In analysis of the 13th research question, the value of the Pearson *r* Correlation Coefficient is 0.5687. This is a significant positive correlation, which means there is a tendency for a high X variable (Perception) go with a high Y variable (Posttest scores). A summary of the experimental research's findings, as well as conclusions, implications, and recommendations are outlined in the next chapter.

CHAPTER VI

FINDINGS, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter presents the findings of the experimental research, conclusions, implications, and recommendations. The purpose of this experimental research was to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment. Successful completion of Coordinate Algebra determines whether students receive a high school diploma and without a high school diploma students are ensuring themselves lives filled with low paying jobs, short-term employment, and a greater possibility of being incarcerated.

The dependent variables for this experimental research were the following: (a) the posttest Coordinate Algebra scores for all students in the control group whose teachers will use traditional methods of teaching Coordinate Algebra, (b) the posttest Coordinate Algebra scores for all students in the experimental group whose teachers will use the TI-84 Graphing Calculator, (c) the students' perception on the impact of utilizing the TI-84 Plus Graphing Calculator, and (d) the teachers' perception on the impact of utilizing the TI-84 Plus Graphing Calculator.

The independent variables for this experimental research were: (a) the groups the students are in with 1 = control (traditional method) and 2 = experimental\treatment (TI-

84 Plus Graphing Calculator), (b) the gender of the student, (c) the pretest score, (d) the teacher's years of experience, (e) student attendance, (f) socioeconomic status, and (g) difference in Coordinate Algebra score gains (postscore/prescore). The experimental research utilized an independent *t*-test to the Coordinate Algebra pretest data to compare the experimental group and the control group for initial variations. Paired sample *t*-tests and Pearson r were employed to test 13 hypotheses.

Findings

An independent t-test was applied to the Coordinate Algebra pretest data to compare the experimental group and the control group for initial variations. In the analysis, the independent *t*-test results revealed no significant difference between the groups prior to the treatment. The researcher posed 13 research questions and found the following:

1. There was no significant difference between the means of both the control and experimental groups' pretest scores;
2. A significant difference existed between the means of the pretest and posttest scores of the experimental group;
3. A significant difference existed between the means of the pretest and posttest scores of the control group;
4. A significant difference existed between the means of the gain scores of both the control group and the experimental group;
5. A significant difference existed between the means of the pretest and posttest scores of the males in the experimental group;

6. A significant difference existed between the means of the pretest and posttest scores of the females in the experimental group;
7. A significant difference existed between the means of the pretest and posttest scores of the students who receive free/reduced lunch in the experimental group;
8. There was a significant positive correlation between student's attendance rate and their posttest scores;
9. There was a significant positive correlation between student's perception of utilizing the TI-84 Plus Graphing Calculator and their posttest scores;
10. There was no significant difference between the gain scores of both the males and the females in the control group;
11. There was no significant difference between the gain scores of both the males and the females in the experimental group.

Students from the experimental group made the following comments in an interview conducted by the researcher on November 3, 2014:

Student 1: The Graphing Calculator makes calculations easier in more ways than one.

Student 2: The Graphing Calculator made it easier to find solutions to a system of equations in order to solve hard problems. It helped in understanding the problems and cut down work time.

Student 3: Being that time is limited, the calculator was able to help me multiply the answers in an efficient way. Also, this concept doesn't necessarily have a lot of steps but there are a lot of numbers involved so the calculator keeps you from getting confused.

Student 4: It made the work easy because you don't have to try and do it in your head.

Student 5: The graphing calculator helped me learn by helping me with the section that I needed help.

Student 6: It helped me get the answers faster.

Student 7: The Graphing Calculator helped me solve the problems that was hard to solve on paper. It makes the problem solving easier when we put them in the calculator.

Student 8: It made the complicated problems simple to do. Also the graphing calculator breaks the problem down to the lowest point.

Student 9: It helped me solve problems that had a lot of big numbers.

Student 10: The graphing calculator is advanced and we are learning advanced math so it works pretty good.

Student 11: The Graphing Calculator helped me learn the new concepts by making it understandable. It helped me correctly answer the question without overworking myself.

Student 12: It makes the work really easy.

Student 13: The Graphing Calculator makes calculations easier.

Student 14: The Graphing Calculator helps me a lot because the calculators we had in middle school did not help.

Student 15: The Graphing Calculator helps me learn new math concepts because it makes math easier and it gives you step by step solutions.

Student 16: It helped me so that I did not have to take a lot of time to solve by hand.

Student 17: The Graphing Calculator makes hard problems easy."

Student 18: It makes graphing equations easy.

Student 19: It helped me solve long problems in half the time."

Student 20: It makes math fun.

Student 21: The Graphing Calculator helps get the solution quicker and more efficiently.

Student 22: The Graphing Calculator allows you to switch functions to get an answer that regular paper calculation wouldn't give you.

Student 23: It makes the work easy.

Student 24: We should be able to use the Graphing Calculator in our support class.

Student 25: It makes finding a linear regression easy.

The researcher also solicited the direct supervisor of the teacher to observe both the control and experimental groups and to provide feedback for additional documentation. The direct supervisor provided the following feedback from observing the control group:

- Students are attentive
- Students are completing the assigned task

- Students are talking to peers

The direct supervisor also provided the following feedback from observing the experimental group:

- Students are attentive and focused
- Students are completing the assigned task
- Students are using technology to make calculations
- Students are volunteering to answer questions

Conclusions

The findings of this experimental research suggest that Coordinate Algebra students are able to utilize graphing calculators in effective ways. This experimental research provides substantiation that the utilization of the graphing calculator in the mathematics classroom should consistently be a part of the students' learning development. Additionally, the regularity and quality of use of the graphing calculator needs to be taken into consideration and not just the presence of the graphing calculator, in order for the graphing calculators to be effective tools for learning in the mathematics classroom. The findings in this experimental research also suggest the role of professional development in helping teachers understand how to maximize the potential of graphing calculators in teaching Coordinate Algebra is significant.

Implications

Teachers enhance the opportunities for students to learn advanced mathematics topics that involve graphing and computing by incorporating the use of graphing calculators into their mathematics classrooms. By affording students the opportunity to learn advanced mathematical concepts through experience using a graphing calculator, students enhance mathematical knowledge by allowing them to see a visual of the results displayed on the screen. The graphing calculator also affords students the opportunity to explore advanced mathematical concepts through personal experience. Ford (2008) suggests that graphing calculators have several ways to present information and can perform routine operations faster than what pencil and paper manipulations. Utilizing the graphing calculator in the mathematics classroom also affords students the opportunity to get an instantaneous response to a problem. Instant feedback creates excitement and increases students' interest in the mathematical concept being taught. Students are able make discoveries and explore ideas through experience when allowed to use interactive technology. As a result, the students' discoveries are more real, and the students gain a more abstract and deeper understanding of the mathematical concept being taught (Sabry & Barker, 2009).

Many mathematics educators and constructivists view graphing calculators as being beneficial in the mathematics classroom because the graphing calculator allows students to discover relationships between advanced mathematical concepts by giving different representations (Ford, 2008). Affording students the opportunity to experience concepts utilizing the graphing calculator has many benefits. Graphing calculators do not negatively affect the learning of traditional mathematics, graphing calculators in fact allow students to become superior problem solvers. Hollar and Norwood (cited in Bismarck, 2009) discovered that mathematics students, who were given the opportunity to have a firsthand learning experience of using the graphing calculator, felt more comfortable with data in real-world situations than the conventional students who did not use graphing calculators. The use of graphing calculators in the mathematics classroom gives students an opportunity to explore the effects of different values on functions and graphs and have a personal experience with analyzing data (Ford, 2008).

Graphing calculators also aid struggling students in developing mathematics abilities by learning through personal experience. Students are able to use graphing calculators to graph functions of a higher degree and as a support for answering and explaining problems. Using graphing calculators encouraged students to discover mathematical concepts and the experience acquired from its usage give students a deeper understanding of the correlation between complex graphs and equations. Students are able to view findings as a graphical representation on the display screen of a graphing calculator and discover that it is less complicated to learn mathematical concepts. Using the graphing calculator was also faster than calculating and graphing by hand. Students experience mathematical representations through the graphing calculator which helped the students gain a deeper understanding of the mathematical concept, and make connections that help improve their overall comprehension. Graphing calculators increase computational skills and meaningful understanding of key mathematical concepts, make it less complicated for students to access and see both graphical and computational results, and improve scores on non-calculator assessments. As a result of the many benefits of utilizing the graphing calculator, today's mathematics classrooms have experienced an increased use of technology and graphing calculators (Ford, 2008).

The graphing calculator "has a positive effect on students' understanding of graphs and their connection to algebraic representation" (Ford, 2008, p. 8). Graphing calculators facilitate the mathematics learning process by eliminating some of the mundane or tedious calculations. Graphing calculators expand the space that is integral to mathematical thinking and problem-solving. Graphing calculators also expand the capacity to raise mental processes that may otherwise not be as easy or even impossible to engage in. In doing so, graphing calculators help to both develop and assess mathematical thinking and problem-solving.

"A positive classroom environment creates a positive foundation for direct instruction to occur" (Idris, 2006, p. 2), and students need to feel wanted and valued in the mathematics classroom. According to Ford (2008), "Learning with a calculator contributes broadly to student achievement as measured on tests that allow calculator use" (p. 4). According to the Center for Implementing Technology in Education (2015), proper use of graphing calculators in the mathematics classroom improves students' ability to comprehend advanced mathematical concepts and answer challenging problems. According to the student survey results for this experimental research, nearly 88% of the students in the experimental group said they were either very comfortable or comfortable using the TI-84 Plus Graphing Calculator and 92% of the students in the experimental group said that the TI-84 Plus Graphing Calculator had a positive impact on their achievement.

Recommendations

District Leaders

In utilizing the graphing calculator in the mathematics classroom, the role of district leaders is also critical. The actions of district leaders embracing the utilization of graphing calculators will encourage and support mathematics teachers as they engage in learning opportunities and explore new tools to enhance instruction. District leaders can ensure that the utilization of graphing calculators is prioritized and that the mathematics teachers feel that they have the necessary resources to ensure success in the mathematics classroom. District leaders must:

- Provide a vision for the teaching and learning of mathematics that includes the utilization of the graphing calculator.
- Provide specific mathematics curriculum outcomes prescribed by the Georgia Department of Education.
- Provide learning resources (e.g., student textbooks and teacher resource books) that provide teachers with opportunities to use a wide range of supports, including graphing calculators, manipulative materials, and other technologies.

School Administration

In utilizing the graphing calculator in the mathematics classroom, the role of the school administration is critical throughout every stage of implementation. The actions and attitudes of school leaders embracing the utilization of graphing calculators will encourage and support mathematics teachers as they engage in learning opportunities and explore new tools to enhance instruction. Through their role as instructional leaders, school administration can ensure that the utilization of graphing calculators is prioritized and that the mathematics teachers feel comfortable using it. School administration must:

- Promote the use of the graphing calculator in the mathematics classroom by playing multiple roles in the change process; including motivator, facilitator, leader, role model, and resource provider.

- Maintain close working relationships with district-level leaders and technology coordinators. By working together as a team of change leaders, these individuals are able to ensure that technology implementation is carried out in an effective manner that aligns with the districts vision for technology.
- Influence school culture to encourage the scaling up of technology to attract attention to teacher successes through the use of newsletters and bulletin boards.
- Support and encourage mathematics teachers who want to go to conferences and participate in staff development.
- Attend mathematics conferences to see what other schools are doing, what other mathematics teachers are doing to integrate graphing calculators, and what principals are doing to encourage the use of graphing calculators in their schools and mathematics classrooms.

Teachers

A great deal of the responsibility for successful utilization of the graphing calculator in the mathematics classroom inevitably falls upon individual mathematics teachers. The most critical element in technology use is the preparedness and skill level of those who employ it. Mathematics teachers need high-quality professional development that leads to a professional community centered on the utilization of the graphing calculator into the mathematics curriculum. Viewed in terms of teaching, mathematics teachers should have basic graphing calculator skills and be able to:

- Use graphing calculators to support learning new mathematical concepts.

- Design or adapt graphing calculator-supported learning activities.
- Manage student-centered, graphing calculator-supported activities.
- Assess student skills within the context of graphing calculator-supported activities.

Parents

Societal change commands that students' mathematical needs today are in many ways different from those of their parents. These differences are expressed not only with respect to mathematical content, but also with respect to instructional methodology. As a result, it is critical that educators take every opportunity to discuss changes in mathematical pedagogy with parents and why these changes are important. Parents who understand the reasons for changes in assessment and instruction will be able to support their children in utilizing the graphing calculator or any mathematical endeavor by:

- Fostering positive attitudes towards mathematics and technology.
- Emphasizing the importance of mathematics and technology in their child's life.
- Providing assistance to their children with mathematical activities at home.
- Helping to ensure that their children become confident, independent learners of mathematics.

Future Research

Potential future research should center on what caused the graphing calculator to have the results that were examined in the 11th and 13th research questions. Why was there a significant positive correlation between students' test scores and there attendance;

and a significant positive correlation between students' test scores and their perception of the impact of utilizing the TI-84 Plus Graphing Calculator? Should graphing calculators be used in all math classes, due to this experimental research revealing that the use of TI-84 Plus Graphing Calculator aided in improving student scores? Future research should concentrate on finding larger groups to participate in comparable research. Larger sample sizes may possibly bring more accurate results. Larger sample sizes may also remove any uncertainties that may exist pertaining to the results of the present research, particularly the significant differences in scores between the students utilizing the TI-84 Plus Graphing Calculator and those students that did not use it. Future research should also explore how the use of graphing calculator may help close achievement gaps in gender and SES. If the graphing calculator can be used to close the gender gap and close the gap between students of low and high SES students in mathematics, then this could create an opportunity that present and future generations can use to establish a level playing field for all students to succeed.

Summary

This final chapter discussed the conclusions of this experimental research, the findings, the implications, and recommendations for future research. This experimental research produced varied results on the issue of the TI-84 Plus Graphing Calculator being an effective treatment for increasing the student's scores on Coordinate Algebra Milestones. The difference between the experimental groups' pretest/posttest scores as a result of utilizing the TI-84 Plus Graphing Calculator was significant. However, there was not a significant relationship between the males and females as a result of utilizing the TI-84 Plus Graphing Calculator. Past studies like such as Lubienski (2007), stated that boys outperform girls in higher level mathematics and that high SES students are far superior mathematically to their low SES counterparts. The present experimental research did not replicate those findings. However, it should be noted that in both groups the female students did score higher than the male students.

APPENDIX A

Letter of Consent to Principal

Dear Principal:

My name is Brandon Fears and I am a doctoral student at Clark Atlanta University in the Department of Educational Leadership. I am employed within this school district as a mathematics teacher. I am conducting a research investigation on a comparison of the impact of use of technology vs. traditional teaching methodology on students' scores on Coordinate Algebra (Algebra I GSE) Milestones. The research investigation will consist of the distribution of both a teacher and a student survey. As part of documentation, the researcher will develop and maintain weekly journals and logs from both the teacher and the students to create ongoing records about what they're doing and learning in Coordinate Algebra (Algebra I GSE) and maintain a chronological record of their learning experiences.

I would like to include your school in my study because of your school's demographics and your school's commitment to excellence. Inclusion of your school in this study will provide valuable information for the research investigation, and I will be more than willing to share the results with you. There are no risks associated with this study. To maintain confidentiality, the name of your school will be changed and all records will be kept in private and in a locked file. Upon any publication of the results, no information will be included to make it possible to identify participants. Participation will occur on a voluntary basis and participants may drop out of the study at any time if they choose to no longer participate.

I would greatly appreciate it if you would respond to this e-mail confirming/declining your school's participation in the study. If you have any questions about the research you may contact me at 404-441-8221. You may also contact my advisor, Dr. Barbara Hill at 404-880-6126.

Thank you for your time and consideration.

Brandon Fears
Doctoral Student

APPENDIX B

Parental Consent Form

A Comparison of the Impact of Use of Technology vs. Traditional Teaching Methodology on Students' Scores on Coordinate Algebra Milestones

You are invited to be in a research study of the impact of technology on mathematics achievement. You were selected as a possible participant because your child is a 9th grade Coordinate Algebra student. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Brandon Fears (Clark Atlanta University Doctoral Student)

Background Information:

The purpose of this experimental research is to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment.

Procedures:

If you agree to be in this study, we would ask you to do the following things:

Take part in Coordinate Algebra lessons developed by Texas Instrument utilizing the TI-84 Plus Graphing Calculator. The students will continue to adhere to the established school district course of study, use the same textbooks, and will receive the same body of content knowledge. The students will take a common pretest assessment, created by the school district, during the first week of the semester. Near the end of the first quarter of the semester, the students will take a common post-test assessment, created by the school district, to determine whether if the TI-84 Plus Graphing Calculator will increase the probability of the students passing the Coordinate Algebra Georgia Milestone Assessment.

Risks and Benefits of Being in the Study:

Dissatisfaction at poor performance or frustration are minor but common risks of this study. However, the benefit of this study is determining a means of increasing achievement in mathematics and increasing the probability of students passing the Coordinate Algebra Georgia Milestones Assessment.

Confidentiality.

The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a participant. Research records will be kept in a locked file; only the researcher will have access to the records.

Voluntary Nature of the Study.

Your decision whether or not to participate will not affect your current or future relations with the researcher, or Clark Atlanta University. By volunteering to participate in the Coordinate Algebra lessons developed by Texas Instrument utilizing the TI-84 Plus Graphing Calculator, you have the freedom to withdraw at any time without affecting those relationships previously identified.

Contacts and Questions:

The researcher conducting this study is Brandon Fears (bfears1974@gmail.com). You may ask any questions you have now. If you have questions later about the research, you may contact the researcher(s) at: Phone: (404) 441-8221.

If you have any questions now, or later, related to the integrity of the research, (the rights of research subjects or research-related injuries, where applicable), you are encouraged to contact Dr. Georgianna Bolden at the Office of Sponsored Programs (404 880-6979) or Dr. Paul I. Musey, (404) 880-6829 at Clark Atlanta University.

Statement of Consent: I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature ____ Date: __________________

Signature of Investigator ___________________________ Date: ___________________

NOTE: Children under the age of eight (8) require the permission of their parent(s) or legal guardians to participate in any type of research; those over the age of eight (8) require permission from their parent(s)/legal guardian, in addition to their Assent to participation.

PLEASE consider the attainment of informed consent as a process within the research design that requires your attention. The consent/assent forms that are approved by the IRB committee will be stamped as such and returned to the researcher and must be utilized throughout the research study.

APPENDIX C

Teacher Survey

The purpose of this survey is to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment. Your contribution to this research is invaluable and will provide beneficial information for educators. Because of the sensitivity of the matter, your identity will remain protected, making you a completely anonymous participant.

If you are willing to participate in this research, please click on the link below and complete the survey. The survey consists of 28 questions that should take no more than 10-15 minutes to answer.

Directions: Answer the following questions by selecting the answer that best describes you.

1. What is your gender?

   a. Male   b. Female

2. How long have you been a full-time teacher?

   a. 0-5 years   b. 6-10 years   c. 11-20 years
   d. 21+ years

3. How many years have you taught in a title one school?

   a. Less than 1 year   b. 1-2 years   c. 3 years or more

4. What is your ethnicity?

   a. African American   b. Caucasian   c. Hispanic
   d. Biracial   e. Asian   f. Other

5. In which age range do you fall?

   a. 20-30   b. 31-40   c. 41-50   d. 51+

6. What type of setting best describes the undergraduate teacher preparation program that you attended?

   a. Public Institution b. Private Institution
   c. Alternative Education Program

7. Which best describes the type of institution that you attended for your teacher preparation program/alternative education program?

   a. Historically Black College or University (HBCU) b. Non-HBCU

8. Was your undergraduate major mathematics?

   a. Yes b. No

9. Did you learn about the constructivist theory of learning in your undergraduate teacher preparation program/alternative education program?

   a. Yes b. No c. I do not know d. I do not remember

10. How often do you receive professional development on utilizing technology at your school?

    a. Weekly b. Bi-Monthly c. Monthly
    d. Less than once per month e. Never

11. How often do you attend mathematics conferences or workshops outside of your school?

    a. Weekly b. Bi-Monthly c. Monthly
    d. Less than once per month e. Never

12. How often do you reflect on your instructional practices?

    a. Daily b. Weekly c. Bi-Monthly
    d. Monthly e. Less than once per month f. Never

13. How often do you/did you receive professional development on utilizing the TI-84 Plus Graphing Calculator instructional strategies?

    a. Weekly b. Bi-Monthly c. Monthly
    d. Less than once per month e. Never

14. How often do you/did you read educational material about graphing calculators?

a. Weekly b. Bi-Monthly c. Monthly
d. Less than once per month e. Never

15. How often do you/did you attend educational conferences or workshops outside of your school related to utilizing graphing calculators?

a. Weekly b. Bi-Monthly c. Monthly
d. Less than once per month e. Never

16. Prior to this research, how of do/did your students use graphing calculators in your classes?

a. Daily b. Weekly c. Bi-Monthly
d. Monthly e. Less than once per month f. Never

17. Are graphing calculators made available to the students in your classes?

a. Yes b. No

18. Are students required to provide their own calculators?

a. Yes b. No

19. Does the school provide each student with his/her own calculator?

a. Yes b. No

20. Does the school provide teachers with a classroom set of calculators?

a. Yes b. No

21. How many years have you taught Coordinate Algebra?

a. First year b. 1-3 years c. 4-6 years d. 7+ years

22. How many years have you used graphing calculators with your classes?

a. 5 years or less b. 6-11 years c. 11+ years

23. How often do students use graphing calculators in your classes?

a. Daily b. Weekly c. Monthly

24. Prior to this research, in which of the following ways did students use graphing calculators in your classes?

    a. Homework   b. Class Work   c. Classroom Assessments

25. Prior to this research, which of the following purposes did students use graphing calculators in your classes?

    a. Operations   b. Drill/Practice   c. Problem Solving
    d. Conceptual Understanding

26. Are you comfortable utilizing the TI-84 Plus Graphing Calculator in your classes?

    a. Not comfortable   b. Somewhat   c. Comfortable
    d. Very comfortable

27. Are your students comfortable utilizing the TI-84 Plus Graphing Calculator in your classes?

    a. Not comfortable   b. Somewhat   c. Comfortable
    d. Very comfortable

28. How does the utilization of the TI-84 Plus Graphing Calculator impact student achievement in mathematics.

    a. No impact   b. Positive impact   c. Negative impact

APPENDIX D

Student Survey

The purpose of this survey is to examine the effects of the use of the TI-84 Plus Graphing Calculator on the achievement of Coordinate Algebra students to ascertain if the use of this tool promotes student achievement and increases the probability of students passing the Coordinate Algebra Milestones Assessment. Your contribution to this research is invaluable and will provide beneficial information for educators. Because of the sensitivity of the matter, your identity will remain protected, making you a completely anonymous participant.

If you are willing to participate in this research, please click on the link below and complete the survey. The survey consists of 17 questions that should take no more than 5-10 minutes to answer.

Directions: Answer the following questions by selecting the answer that best describes you.

1. What is your gender?

   a. Male b. Female

2. What is your ethnicity?

   a. African American b. Caucasian c. Hispanic
   d. Biracial e. Asian f. Other

3. How often do you receive training on utilizing technology at your school?

   a. Weekly b. Bi-Monthly c. Monthly
   d. less than once per month e. Never

4. How often do you/did you receive training on utilizing the TI-84 Plus Graphing Calculator instructional strategies?

   a. Weekly b. Bi-Monthly c. Monthly
   d. less than once per month e. Never

5. How often do you/did you read educational material about graphing calculators?

   a. Weekly b. Bi-Monthly c. Monthly
   d. Less than once per month e. Never

6. Prior to this year, how often do/did you use graphing calculators in your mathematic classes?

   a. Daily b. Weekly c. Bi-Monthly
   d. Monthly e. Less than once per month f. Never

7. Are graphing calculators made available to the students in all mathematics classes at your school?

   a. Yes b. No c. I don’t know

8. Are students required to provide their own calculators?

   a. Yes b. No

9. Does the school provide each student with his/her own calculator?

   a. Yes b. No

10. Does the school provide teachers with a classroom set of calculators?

    a. Yes b. No

11. How many times have you taken Coordinate Algebra?

    a. 1st time b. 2nd time c. 3rd time d. 4th time

12. How many years have you used graphing calculators with your mathematics classes?

    a. 2 years or less b. 3-4 years c. 5+ years

13. How often do students use graphing calculators in your mathematics classes?

    a. Daily b. Weekly c. Monthly

14. Prior to this year, in which of the following ways did students use graphing calculators in your mathematics classes? (Choose all that apply)

    a. Homework   b. Class Work   c. Classroom Assessments

15. Prior to this year, which of the following purposes did students use graphing calculators in your mathematics classes? (Choose all that apply)

    a. Operations   b. Drill/Practice   c. Problem Solving
    d. Conceptual Understanding

16. Are you comfortable utilizing the TI-84 Plus Graphing Calculator in your mathematics class?

    a. Not comfortable   b. Somewhat   c. Comfortable
    d. Very comfortable

17. How does the utilization of the TI-84 Plus Graphing Calculator impact student achievement in mathematics.

    a. Negative impact   b. No impact   c. Positive impact

APPENDIX E

Students' Daily Usage Log

TI-84 Plus Graphing Calculator

Student	Objective	Date
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25.		
26.		
27.		
28.		
29.		

APPENDIX F

Students' Weekly Journal Entry

1. Identify three things you learned this week.

2. Identify two things you would like to know more about.

3. Identify one question you still have.

4. How did the graphing calculator contribute to your learning the new mathematics concepts?

APPENDIX G

End-of-Course Diagnostic Test

CCGPS COORDINATE ALGEBRA

End of Course Diagnostic Test

Coordinate Algebra Formula Sheet

Below are the formulas you may find useful as you work the problems. However, some of the formulas may not be used. You may refer to this page as you take the test.

Area

Rectangle and Parallelogram $A = bh$

Triangle $A = \frac{1}{2}bh$

Circle $A = \pi r^2$

Trapezoid $A = \frac{1}{2}(h)(b_1 + b_2)$

Circumference

$C = \pi d \quad \pi \approx 3.14$

Volume

Rectangular Prism/Cylinder $V = Bh$

Pyramid/Cone $V = \frac{1}{3}Bh$

Sphere $V = \frac{4}{3}\pi r^3$

Surface Area

Rectangular Prism $SA = 2lw + 2wh + 2lh$

Cylinder $SA = 2\pi r^2 + 2\pi rh$

Pythagorean Theorem

$a^2 + b^2 = c^2$

Mean Absolute Deviation

$$\frac{\sum_{i=1}^{n} |x_i - \bar{x}|}{n}$$

the average of the absolute deviations from the mean for a set of data

Distance Formula

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Slope Formula

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Midpoint Formula

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

Interquartile Range

the difference between the first quartile and third quartile of a set of data

COORDINATE ALGEBRA – SECTION I

1 The value, V, of an automobile n years after purchase can be modeled with this formula.

$$V = I(1-d)^n$$

In the formula, I is the purchase price, in dollars, of the automobile and the expression $(1-d)^n$ is known as the *decay factor*.

A car purchased for $21,000 has a decay factor of 0.7. What is the present value of the car?

A $6,300
B $14,700
C $30,000
D $35,700

2 This expression is a product.

$$4(2a+3b)(5x+y)$$

As written, how many factors make up this product?

A 2
B 3
C 4
D 5

3 An artist paints designs on T-shirts. It takes 15 minutes to set up the equipment and 40 minutes to clean the equipment and put it away. Once everything is set up, it takes the artist about 12 minutes to paint a design on each T-shirt.

Which equation BEST models the number of shirts, s, the artist can make in 127 minutes?

A $12s - 55 = 127$
B $55 - 12s = 127$
C $12s + 25 = 127$
D $12s + 55 = 127$

4 Andrew invested $1000 in his savings account. The interest rate, r, is compounded annually. Which equation shows the amount, A, in his account after x years?

A $A = 1000(1-r)^x$
B $A = 1000(1+r)^x$
C $A = 1000(r-1)^x$
D $A = 1000r^x$

5 If the value of z decreases by 2, how does the value of the expression $y(16+z)$ change?

A decreases by 2y
B decreases by 32y
C increases by 14y
D increases by 18y

COORDINATE ALGEBRA – SECTION I

6 **Look at the system of equations.**

$$ax + by = c$$
$$dx + ey = f$$

The system has a unique solution, (x, y). Which system of equations has the same solution?

A $\begin{aligned} ax + by &= c \\ dx - ey &= f \end{aligned}$

B $\begin{aligned} ax + by &= c \\ (a + e)x + (b + d)y &= c + f \end{aligned}$

C $\begin{aligned} ax + by &= c \\ (a + d)x + (b - e)y &= c + f \end{aligned}$

D $\begin{aligned} ax + by &= c \\ (a + 2d)x + (b + 2e)y &= c + 2f \end{aligned}$

7 **What is the x-value of the solution to this system of equations?**

$$3x + 2y = 6$$
$$2x + y = 2$$

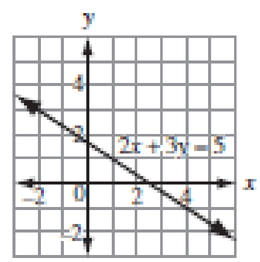
A $x = -2$

B $x = \frac{10}{7}$

C $x = 2$

D $x = 4$

8 **This coordinate plane shows the graph of an equation.**



Which statement about the solutions of the equation MUST be true?

A If the x-value of a solution is positive, then the corresponding y-value is negative.

B If the x-value of a solution is negative, then the corresponding y-value is positive.

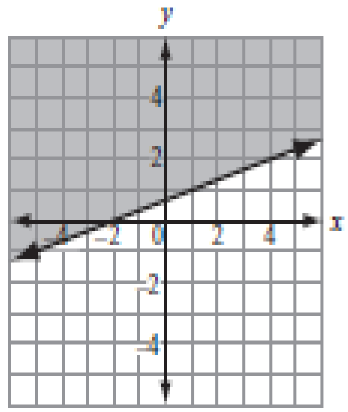
C There is no solution for which both the x-value and the y-value are integers.

D There is only one solution for which both the x-value and the y-value are integers.

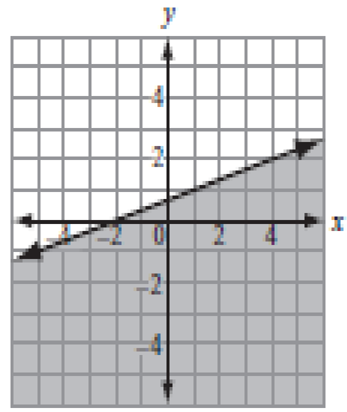
COORDINATE ALGEBRA – SECTION I

9 Which graph shows the solution set for the inequality $x > 3y - 2$?

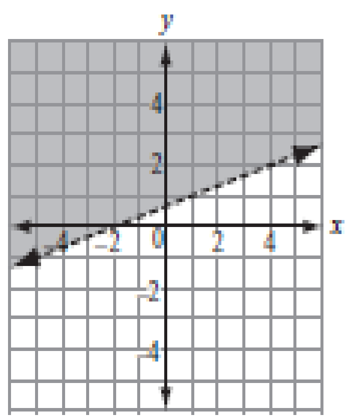
A



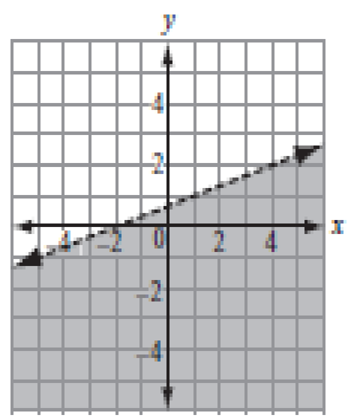
B



C



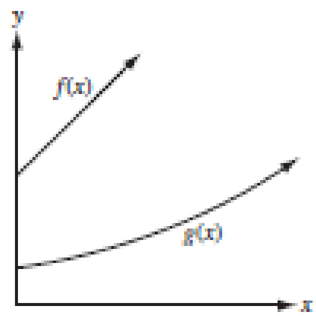
D



COORDINATE ALGEBRA – SECTION I

10 **This coordinate plane shows two functions of x.**

- **$f(x)$ is an increasing linear function.**
- **$g(x)$ is an increasing exponential function.**



Based on the information, which statement is true for all real values of the domain $x \geq 0$?

A $f(x) = g(x)$ for only one value in the domain
B $f(x) = g(x)$ for many values in the domain
C $f(x) > g(x)$ for all values in the domain
D $f(x) < g(x)$ for all values in the domain

11 **These tables show points from two linear functions.**

Function 1

x	$f(x)$
1	5
2	7
3	9
4	11

Function 2

x	$f(x)$
1	–1
2	2
3	5
4	8

Which of these linear functions has a slope GREATER than the slope for Function 1 and LESS than the slope for Function 2?

A $f(x) = 1.5x + 1$
B $f(x) = 2x + 2.5$
C $f(x) = 2.5x - 6$
D $f(x) = 3x + 2$

12 Which table BEST describes a function with exponential decay?

A

x	$f(x)$
1	81
2	27
3	9
4	3

B

x	$f(x)$
1	80
2	70
3	50
4	20

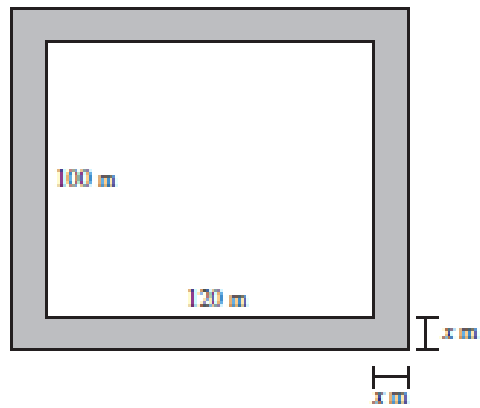
C

x	$f(x)$
1	80
2	76
3	67
4	51

D

x	$f(x)$
1	2
2	4
3	8
4	16

13 A rectangular field is 100 meters in width and 120 meters in length. The dimensions of the field will be expanded by x meters in each direction, as shown in the diagram.



Which function describes the perimeter of the new field in terms of x?

A $f(x) = 220 + 4x$
B $f(x) = 220 + 8x$
C $f(x) = 440 + 4x$
D $f(x) = 440 + 8x$

14 Which function shares at least one point with the function represented by the equation $y = 2^x$?

A $y = x$

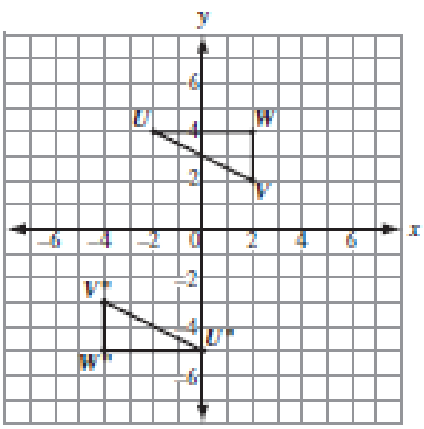
B $y = -x$

C $y = -2^x$

D $y + 2 = x$

COORDINATE ALGEBRA – SECTION I

15 **On this coordinate plane, $\triangle UVW$ has been transformed to form its image, $\triangle U''V''W''$.**



Which statement describes the sequence of transformations?

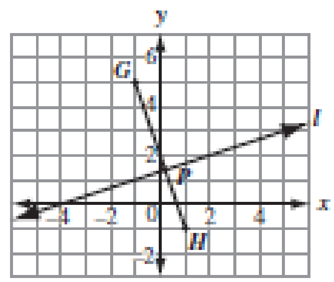
A reflection across the y-axis, followed by a translation of 2 units to the left and 9 units down

B reflection across the x-axis, followed by a reflection across the y-axis

C rotation of 180° about the origin, followed by a translation of 2 units to the right and 1 unit down

D translation of 2 units to the right and 1 unit up, followed by a rotation of 180° about the origin

16 **On the coordinate plane, line l intersects segment $\overline{GH}$ at point P so that $\frac{GP}{PH} = \frac{3}{2}$.**



What are the coordinates of point P?

A (0.1, 1.2)

B (0.1, 1.4)

C (0.2, 1.2)

D (0.2, 1.4)

COORDINATE ALGEBRA – SECTION I

17 On a coordinate plane, $WXYZ$ is a square. Segment $\overline{WZ}$ is one side of the square and has endpoints $W(-8, -5)$ and $Z(-4, -2)$. What is the perimeter, in units, of $WXYZ$?

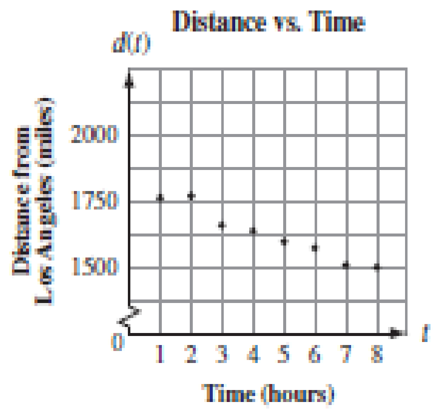
A 5
B 15
C 20
D 25

18 Point N (2, 9) is on $\overline{RS}$. A translation moves point N to its image, $N'(6, 3)$.

What is the distance, in units, between any point on $\overline{RS}$ and its image?

A $\sqrt{10}$
B $\sqrt{40}$
C $\sqrt{52}$
D $\sqrt{130}$

19 A train traveled from Chicago to Los Angeles. The points graphed on this coordinate grid show the distance the train was from Los Angeles after each of the first eight hours of the trip.

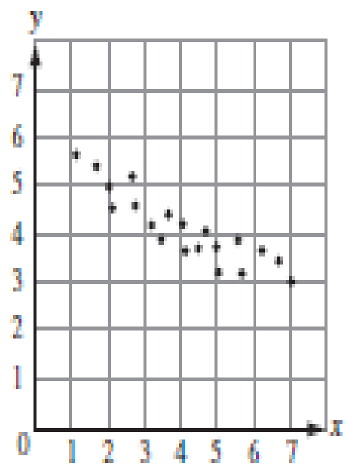


The linear regression model for the data is $d(t) = -58t + 1888$. Based on the regression function, which is the best estimate for the total time it took the train to travel the entire distance?

A 10 hours
B 33 hours
C 53 hours
D 63 hours

COORDINATE ALGEBRA – SECTION I

20 Look at the scatter plot.



What is the MOST likely correlation coefficient, r, between the variables represented in this scatter plot?

A –0.9
B –0.5
C 0.5
D 0.9

REFERENCES

Alagic, M. (2003). Technology in the mathematics classroom: Conceptual orientation. *Journal of Computers in Mathematics and Science Teaching, 22*(4), 381-399.

Altermatt, E. R., & Kim, M. E. (2004). Getting girls de-stereotyped for SAT exams. *Education Digest: Essential Readings Condensed for Quick Review, 70*(1), 43-47.

Bismarck, S. (2009). *Mathematics teacher roles when using technology: Understanding the roles Facilitator and mediator* (unpublished doctoral dissertation). University of Georgia, Athens, Georgia.

Bracey, G. (2006). *Separate but superior*. Retrieved from http://greatlakescenter.org/docs/Policy_ Briefs/Bracey_Gender.pdf

Buddin, R. (2014). Gender Gaps in High School GPA and ACT Scores. Retrieved July 9, 2015, from http://www.act.org/research/researchers/briefs/pdf/2014-12.pdf

Caine, R. (2004). How systems principles can serve as foundation for constructivist learning and teaching. *Educational Leadership, 48*(2), 1-2.

Cennamo, K. S., Ross, J. D., & Ertmer, P. A. (2009). *Technology integration with meaningful classroom use: A standards-based approach.* Retrieved from CengageBrain.com

Center for Implementing Technology in Education. (2015). *Technology Implementation In Schools: Key Factors to Consider*. Retrieved from http://www.cited.org/index.aspx?page_id=187#leadshp

Clark, A. (2006). Changing classroom practice to include the project approach. *Early Childhood Research and Practice, 8*(2), 1-10.

DeAngelis, S. (2014). *Constructivist learning*. Retrieved from http://www. enterrasolutions.com/ 2014/03/stem-education-important.html

Dewey, J. (1916). *Democracy and education. An introduction to the philosophy of Education*. New York, NY: Free Press.

Dix, K. (1999, July). Enhanced mathematics learning: Does technology make a difference. In *Making the difference. Proceedings of the 22nd annual conference of the Mathematics Education Research Group of Australia [MERGA]* (pp. 192-198).

Dix, K. (1999). Enhance mathematics learning: Does technology make a difference? *Mathematics Education Research Group of Australia*, *22*, 192-199.

Dix, K. (2005). *Are learning technologies making a difference*. Retrieved from http://files.eric.ed.gov/fulltext/EJ903884.pdf

Downey, M. (2013, July 10). EOCT results: New higher math standards present challenge to Georgia students. *The Atlanta Journal and Constitution*, pp. A1, A4.

Easton, V. J., & McColl, H. (2006). Statistics glossary. Retrieved from http://www. stats.gla.ac.uk/steps/glossary/index.html. Einstein Project, "Cornerstone Study.” Retrieved from www.einsteinproject.org/cornerstone/ index.shtml

Eccles, J. (2014). Gender role stereotypes, expectancy effects, and parents’ socialization of gender differences. *Journal of Social Issues*, *46*, 186-201.

Ford, S. (2008). The effect of graphing calculators and a three-core representation curriculum on college students' learning of exponential and logarithmic functions (unpublished doctoral dissertation). North Carolina State University, Raleigh, North Carolina.

Ganter, N. (2014). *Representation and character theory of finite categorical groups*. Retrieved from http://arxiv.org/find/math/1/au:+Ganter_N/0/1/0/all/0/1

Ganter, P. (2006). *Comparison of paired samples*. Retrieved from http://www. tnstate.edu /ganter/BIO%20311%20Ch%209%20PairedSample. html#RandSamp

Georgia Department of Education. (2006). *End of course tests* (EOCT). Retrieved from https://www.gadoe.org/Curriculum-Instruction-and-Assessment/Assessment/ Pages/EOCT-Statewide-Scores.aspx

Georgia Department of Education. (2014). *End of course tests* (EOCT). Retrieved from https://www.gadoe.org/Curriculum-Instruction-and-Assessment/Assessment/ Pages/EOCT.aspx

Georgia Department of Education. (2015). *End of course tests* (EOCT). Retrieved from https://www.gadoe.org/Curriculum-Instruction-and-Assessment/Assessment/ Pages/EOCT.aspx

Gray, D. (2008). *Using the Geometer's Sketchpad in the math classroom to improve engagement, transform the learning environment, and enhance understanding*. Retrieved from http://discoverarchive.vanderbilt.edu/handle/1803/571

Heller, J. (2005). *The impact of handheld graphing calculators use on student achievement in algebra I.* Retrieved from http://files.eric.ed.gov/fulltext/ED493688.pdf

Idris, N. (2006). *Exploring the effects of TI-84 Plus on achievement and anxiety in mathematics*. Retrieved from http://www.ejmste.com/032006/d5.pdf

Jones, D. (2006). *The impact of student attendance, socioeconomic status and mobility on student achievement of third grade students in title one schools* (unpublished doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg, VA.

Kenny, R. (2009). *Implementing participatory, constructivist learning experiences through best practices in live interactive performance*. Retrieved from http://uncw.edu/cte/et/articles/vol9_1/kenny.pdf

Kenny, V. (2007). Distinguishing Ernst von Glasersfeld's "radical constructivism" from Humberto Maturana's "radical realism." *Constructivist Foundations, 2*(3), 58-64.

LaLonde, D., Leedy, M. G., & Runk, K. (2003). Gender equity in mathematics: Beliefs of students, parents and teachers. *School Science and Mathematics, 103*(6), 285-292.

Lubienski, S. T. (2007). What we can do about achievement disparities. *Educational Leadership, 65*(3), 54-59.

Martinot, D., & De'sert, M. (2007). Awareness of gender stereotypes, personal. *Social Psychological Educational Journal, 10*, 455-471.

McLeod, S. (2008). *Brunner*. Retrieved from http://www.simplypsychology.org/bruner.html

McLeod, S. (2009). *Jean Piaget*. Retrieved from http://www.simplypsychology.org/ piaget.html

McLeod, S. (2010). *Zone of proximal development*. Retrieved from http://www.simply psychology.org/Zone-of-Proximal-Development.html

Meyers, R. (2009). *The effects of the use of technology in mathematics instruction on student Achievement* (unpublished doctoral dissertation). Florida International University, Miami, FL.

National Council of Teachers of Mathematics (NCTM). (1989). *Principles and standards forschool mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards For school mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics (NCTM). (2011). *Principles and standards For school mathematics*. Reston, VA: NCTM.

National Assessment of Educational Progress (NAEP). (2005). *The nation's report card. National assessment of educational progress*. Washington, DC: National Center for Education Statistics.

Office of Program Evaluation (OPE). (2009). School improvement zone: Final evaluation report. Retrieved from http://blogs.tampabay.com/files/dcps-final-evaluation-of-the-zone.pdf

Ogwu, S. (2004). *Influence of parental socioeconomic status on academic performance of JSS students in Kano Metropolis: Implication for educational* *planning and administration* (unpublished master's thesis). Bayero University, Kano, Nigeria.

Powell, T. (2009). *An exploration of in service teachers' implementation of culturally responsive teaching methods in algebra with African American Students* (unpublished doctoral dissertation). Kansas State University, Manhattan, KS.

Price, B. & Oswald, J. (2006). *Cultural validity in assessment*. Retrieved from https://books.google.com/books?id=50dZBwAAQBAJ&pg=PA44&lpg=PA44&dq=Price+and+Oswald+(2006)+mathematics&source=bl&ots=mDzA7YP86y&sig=SPrnnWFfGLl4nUnpU924fgUulF0&hl=en&sa=X&ved=0ahUKEwjQz4Cmko7LAhVIqR4KHbYYAYsQ6AEIODAE#v=onepage&q=Price%20and%20Oswald%20(2006)%20mathematics&f=false

Public Broadcasting Service (PBS). (2012). *Cost is biggest barrier, pointing to need for free digital classroom resources. Survey*. Retrieved from http://www.pbs.org/ about/ news/archive/2012/teacher-survey-fetc/

Ravid, R. (2005). *Practical statistics for educators* (3rd ed.). New York, NY: University Press of America.

Sabry, K., & Barker, J. (2009). Dynamic interactive learning systems. *Innovations in Education and Teaching International, 46*(2), 185-197.

Spelke, E. (2005). *Sex differences in intrinsic aptitude for mathematics and science*. Retrieved from http://www.wjh.harvard.edu/~lds/pdfs/spelke2005.pdf

Spelke, E. (2008). *Core knowledge*. Retrieved from http://www.wjh.harvard. edu/~lds/pdfs/spelke2008.pdf

Spikes, E. (2008). *The effects of single-gender classrooms and previous middle school gifted math experience on the mathematics achievement of gifted girls in public education* (unpublished doctoral dissertation). Walden University, Naples, FL.

Thanasoulas, D. (2008). *Constructivist learning*. Retrieved from http://www3.telus.net/linguisticsissues/constructivist.html

The Economist. (2009). Light work. Retrieved from http://www.economist.com/business finance/displayStory.cfm?story_id=13788427

Tiedemann, J. (2000). Parents' gender stereotypes and teachers' beliefs as predictors of children's concept of their mathematical ability in elementary school. *Journal of Educational Psychology, 92*, 144-151.

United States Department of Education. (2008). Federal poverty levels. Retrieved from www.ed.gov/about/offices/list/ope/trio/incomelevels.html

United States Department of Education. (2009). No child left behind act of 2001. Retrieved from http://www.ed.gov/nclb/overview/intro/presidentplan/proposal.pdf

Wenglinsky, H. (2005). *Using technology wisely: The keys to success in schools*. New York, NY: Teachers College Press.